ROADS and STREETS

Vol. 80 No. 10 October, 1937

A GILLETTE PUBLICATION
ESTABLISHED 1906

WINTER SERVICE ON CALIFORNIA HIGHWAYS

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THE value of highways rests in the use made of them. The test of a highway organization is largely determined by its success in providing service the year round. From November to May—half the year—the forces of rain and snow and frost work to break down the highway, as well as handicap traffic. In California, frost damage is limited to some extent, but the damage from moisture makes up for any lack in that regard.

During the summer season, the maintenance forces are engaged in repair work. Drainage channels are cleared, and road surfaces patched, reinforced and sealed, looking toward the winter period when every effort will be necessary to keep traffic moving. Under California's climatic conditions, with a long dry season and the probability that practically all rain and snowfall will be concentrated in a 3 or 4-month period, extremes may be anticipated. Rainfall varies throughout the state. Cloudbursts may occur in the desert areas in July and August which may entirely destroy several miles of road. The normal rainfall, however, varies from a fraction of an inch in the desert areas to 100 in. a season in the northwest counties. Snowfall likewise varies from a few inches at the 2,000 ft. elevation to an average of 450 to 500 in. at the summit of the Sierras.

Snow Removal Cost $605,000

The cost of slide removal and repair of storm damage during the 1936-37 winter season on about five thousand miles of rural state highways was $900,000. The cost

A Snow Scene on U.S. 40 Near Soda Springs, California.

Slice Bar Combing Slopes on U.S. 40 Near Donner Summit

of snow removal from some 5,200 miles of road was $605,000 for the same period. All of this work required faithful, consistent effort, as any failure meant a closed road, with loss and possible distress to some community.

The snow removal program has been a somewhat slow development in California. Before a campaign could be considered for a particular route, it was necessary that the road be improved to a standard, both as to alignment and surface, to permit continuous operation of heavy equipment. In the early stages, it was necessary, also, to develop suitable equipment. It was found, for example, that the design of curve and mounting of the push plows was important; that 2-wheel-drive trucks were futile on heavy grades; that standby units must be available; and that quarters for equipment as well as men must be heated and well-supplied with facilities for repairing and servicing trucks and plows.

The extent of snow removal can never be determined in advance, nor is the depth of fall necessarily an indication of the work required. The distribution and moisture content of the snow; the wind and temperatures—all are varying factors.

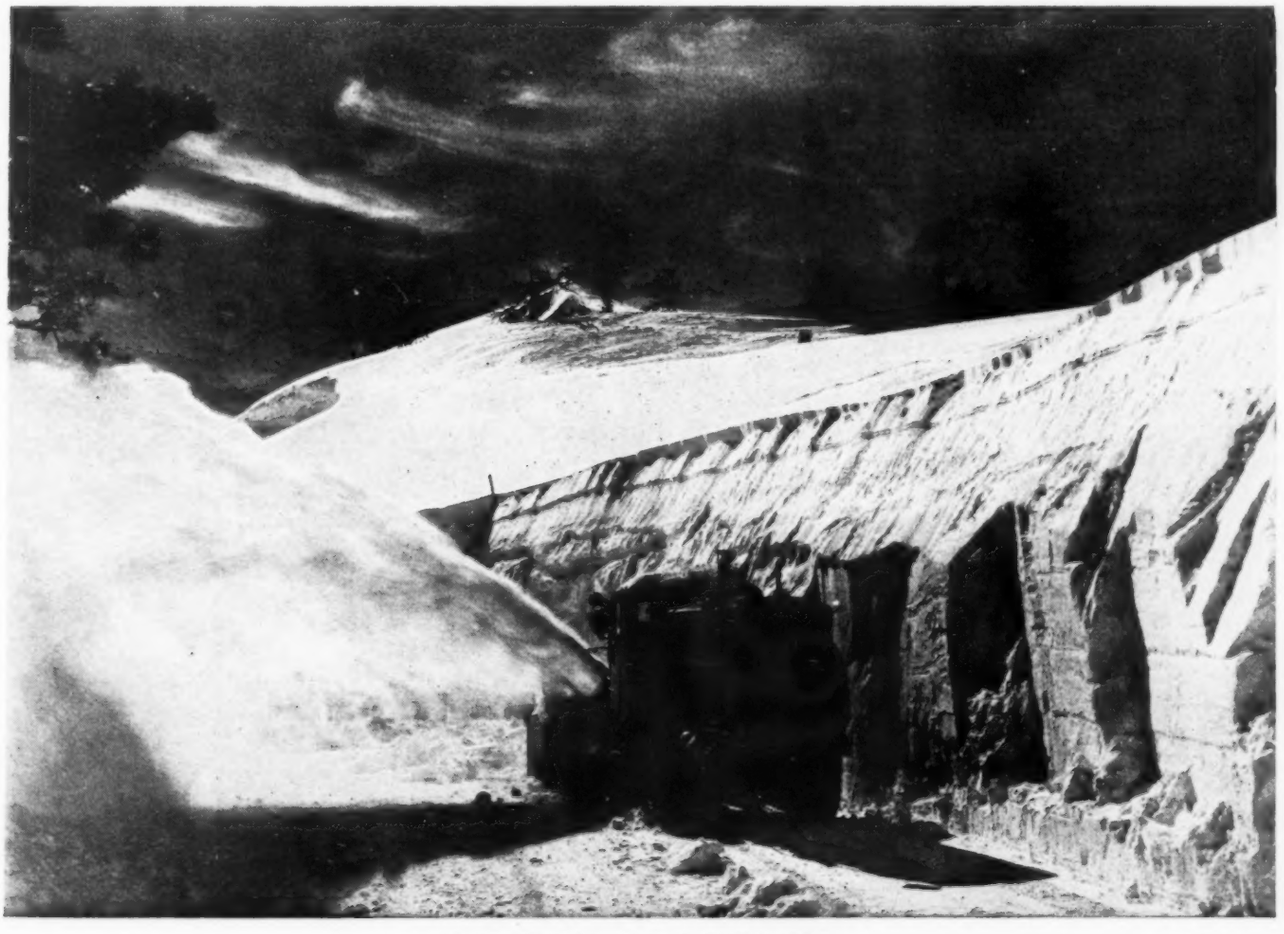
Widening through 8 ft. Snow Walls at Sky Forest, San Bernardino County

Snow Scene Near Squirrel Inn, San Bernardino Mountains, Jan. 15, 1937

Preparing for Snow Period

Success in snow removal in heavy snowfall areas lies in being ready. In California, every effort is made so that a trained, well-equipped force can move in with the first storm. Preparation starts in June, when the possibility of expanding the program is decided and the need for new and replacement equipment considered. Orders for new equipment are placed early in August. Repair of existing equipment is carried out as far as possible. The heavy trucks used with the push plows are equipped with oil tanks during the summer and are not available for overhaul until after Oct. 1, but the shop forces are engaged in reconditioning the rotary and push plows.

Along in October, snow fence is reinstalled and extended as required. Sand is mixed with salt and stored in convenient shelters, ready for sanding icy pavement. The winter quarters for men and equipment are kept in condition. Fuel oil tanks are filled and arrangements made for supplies. Normally, heavy storms are not expected before Nov. 15. The heavy snow period usually lasts during January and February, but there is a very definite hazard for the unwary in the high Sierra mountains early in the season. Snowfall at the rate of one foot



Augur Type Rotary on U.S. 40 in 1937

A "V" Plow with Trailer Type Rotary Widener on the Tahoe-Ukiah Highway

an hour has been recorded. Wind velocities of 60 to 80 miles per hour have been experienced, with temperature of 30 degrees below zero for short priods. Experience has demonstrated the need for early preparation.

The experience and reliability of the men assigned to the work are important. During the summer, the force is scattered throughout the maintenance organization, but with the first storms the drivers and others are assigned to locations with which they are thoroughly familiar.

Traffic Control in Mountain Areas

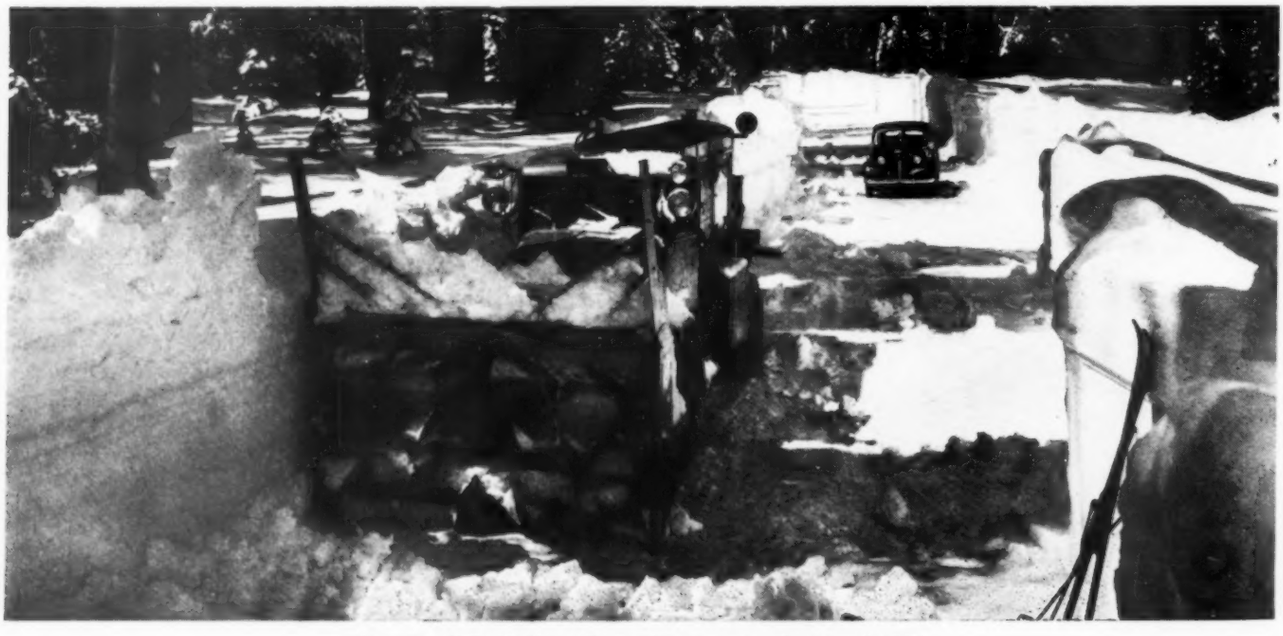
The matter of traffic control in mountain areas is arranged. Gates are installed and watchmen's houses provided at control points. Extra traffic officers are assigned to patrol the area to regulate speed and control truck traffic. In general, the control procedure is as follows: Once a storm begins, and while the pavement is icy, only cars equipped with skid chains are allowed in the area. When the roadway is restricted in width, traffic is convoyed under one-way control. When there is drifting or poor visibility, the gates are closed and traffic stopped until conditions again permit movement in safety. This control is a regular part of operations over Donner Summit on U.S. 40, and north of Bishop on U.S. 395. Controls are established on other routes only as emergency may require.

Of the 100,000 miles of rural road in California, approximately 20,000 miles are in snow areas. Some 6,000 miles of this total are part of the state highway system. Snow removal is carried out on only a limited mileage of the country road system.

Three Types of Snow Removal Work

There are three types of work—light fall areas, heavy fall areas, and roads opened in early spring. In areas where snowfall does not exceed 8 in. for a single storm, clearing is done with tractor graders or light straight blade push plows mounted on 1½ or 2-ton trucks. The work is incidental to maintenance operations.

For areas where a single storm may bring from 50 to 75 in. of new snow, it is necessary to so organize that operations will be continuous for the period of the storm. This requires three full shifts of men to operate, service and repair equipment. There must be standby units ready to go into service or, at least, ample equipment so that one unit may be out of commission without endangering the open-road program.



Opening U.S. 50 Near Camp Sacramento, Spring of 1937

On U.S. 40 between Reno and Sacramento, crossing Donner Summit at an elevation of 7,135 ft., there are four stations from which to operate on a section 120 miles long. At Colfax, near the west end, garage space for light trucks and living quarters for eight men are maintained. At Yuba Pass, 25 miles to the east, there is a 10-stall garage and repair shop, with living quarters for 32 men. Eighteen miles farther east, at Donner Summit, there are garage and shop facilities for ten plows and quarters for 40 men. At Truckee, ten miles farther, is the fourth station. Units are shifted as the need requires. In addition to U.S. 40, these units are used to clear the road north and west of Lake Tahoe, but only when not needed on the main line.

How Snow Removal Is Handled

With all of the preparation, the snow removal theory of operation is simple. The push plows start out and clear the travelled way as soon as 2 or 3 in. of snow has fallen. The rotaries follow behind as soon as a windrow is formed and throw it clear of the shoulders. The detail of operations varies with different routes. For roads protected by trees, etc., where drifting is limited, traffic control is seldom necessary and the routine is one of keeping equipment moving. In Mono County, for a distance of 60 miles the road is at an elevation of 8,000 ft. The snowfall is not great but the wind and cold are severe. Drifting snow is packed hard in a few minutes and soon blocks the push plows. Rotary plows must be relied on to keep an open road.

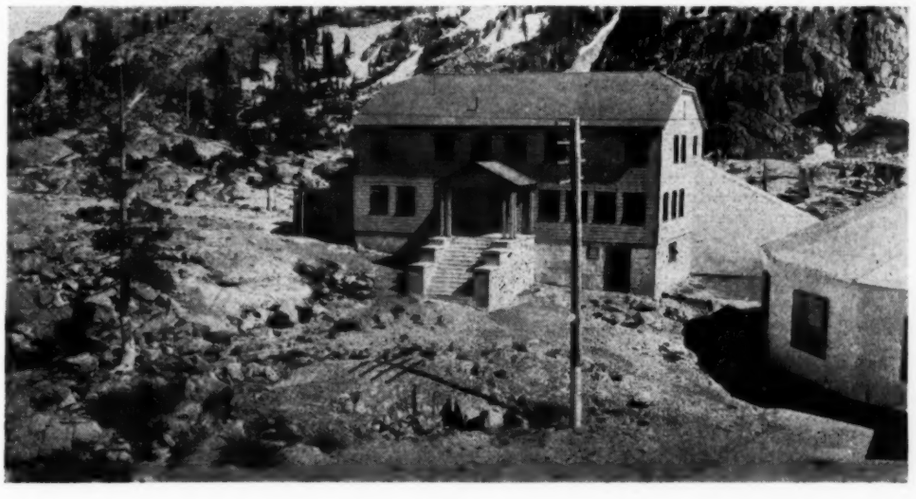
Auger Type Rotary with Drift Comber Attachment in San Bernardino County, California, Feb. 21, 1936

On U.S. 299 in Shasta County, California

All types of equipment have been used for opening roads in the spring. These include tractors and tow graders, and power shovels with oversize dipper bucket. The rotary equipment is most effective, although in heavy, frozen snow progress is slow and the work is extremely hard on equipment. In general, it has been found wise to delay any work on such routes until the portions of the road open to the sun are free from snow, leaving only the deeper drifts to remove. Experience indicates that the road will be opened practically as soon and at much less expense than if work had started as soon as the winter storms ceased.

Guide to Assignment of Equipment

As a guide to the assignment of equipment on mountain work, experience with different type plows indicates the



Living Quarters and Portion of Truck Shed Showing Connecting Stairway at Donner Summit on U.S. 40

Auger Type Rotary Widening on Crestline Highway in San Bernardino Mountains

following capacities, measured in terms of depth of new snow:

Power	*Type*	*Depth of Snow Inches*	*Speeds—m.p.h.*
1½-2 ton trucks	Straight blade push plows	4—8	10-15
3-ton, four-wheel-drive trucks	Straight blade and reversible	6—12	10-15
5-ton, four-wheel-drive trucks	Straight blade speed plows	12—24	6 m.p.h. in 24 in. fall
5-ton, four-wheel-drive trucks	"V" type wth side wing	36—60	6m.p.h. in 24 in. fall
Auger type rotary with self-contained power plant		48 in. new snow	2 m.p.h.
		48 in. new wet snow	1½ m.ph.
		48 in. old packed snow	⅜ m.p.h.

Cost of Snow Removal

The cost of snow removal is difficult to estimate. Last season, the cost of the work averaged $115 per mile throughout the estate. The cost on one 34-mile section carrying a daily traffic of 800 to 1200 vehicles, however, was over $1,800 per mile. The distribution of expense was found to be as follows:

	Per Cent
1. Salaries and Wages	35
2. Materials and Supplies	21
3. Compensation Insurance, Retirement, sick leave, etc.	4
4. Service and Expense	4
5. Equipment Rental (Includes depreciation and repair)	36

The snow removal program serves two distince types of traffic—the normal business and the recreational. The recreational traffic requires development of facilities such as resort accommodations, ski hills, and sport areas. The snow removal program must be forward looking in this regard, and be carried on in a particular section for possibly two or three years before a volume of traffic can be expected. Once an area becomes popular, it is essential that parking space be provided and kept cleared, and that adequate width of road be cleared, in order to avoid traffic jams and hazard to the normal traffic. Experience has shown an increasing interest in winter recreation, and it is anticipated that traffic to favorable areas will increase each season. Once a removal program is initiated for a particular area, it is found impossible to discontinue the work. Care must be used in starting such work, but, once started, there can be no failure in carrying it through.

▼

1,783 Crossing Jobs Finished on July 31—Of the 3,351 projects included in the federal program to eliminate hazards at highway-railroad grade crossings, 1,783 had been completed on July 31, 1937, at an estimated cost of $100,581,106, of which $98,836,834 was supplied from works program funds. The completed work includes 1,275 new separations, 241 reconstruction jobs, and 267 crossings protected by signals or otherwise.

General View of Truck Shed and Dormitory at Crestview in Mono County, California

CONSTRUCTION METHODS AND RECORDS ON A MISSISSIPPI CONCRETE JOB

A New Dual-Drum 34-E Paver and Ingenious Details in Grading, Joint Setting and Concrete Handling Help Make a Successful Contract

By RALPH BOREN,
Project Engineer,
Mississippi State Highway Department,
Sandersville, Miss.

Part 2

Finishing Operations

The operator of the finishing machine, had other duties than merely running it. After the machine passed over an expansion joint he removed the metal holder that held the expansion material in place, and checked to see that it was still in a vertical position. A heavy two-pronged fork was carried on the finishing machine, which would fit down over the expansion material. If the paper had been pushed out of its proper position, it could be adjusted by using this fork. When the joint was checked and in satisfactory position, concrete was well spaded on each side of it, and a light channel cap placed over the expansion material and left in place until the joint was edged. This channel cap was made of ⅛-in. material and extended down only one inch on each side of the expansion material. It held the top edge of the paper straight and the edging was done against it. This left quite a wide opening for a joint in the surface of the pavement but it eliminated any possibility of the edges of the joints overhanging the expansion material and later spawling off when expansion of the concrete caused the joint material to extrude. At the same time it made possible a much straighter joint than can usually be had by edging against the expansion material itself.

The operator also had duties to perform in regard to dummy or contraction joints. After the finishing machine passed over these joints, they were opened by means of a 20-ft. T-iron. This is merely a 20-ft. template with plow handles on each end. It was carried on the back of the finishing machine and as the machine passed over the joint for the last time the operator stepped off, and with the help of another man on one end, set the template off into the green concrete. The weight of the template, together with a rocking motion given by the men on each end of it, caused the vertical part of the T to cut a groove 2 in. deep in the concrete where the dowels were placed for the contraction joint. The center of these dowel as-

Fig. 9. The Finishing Job. Ord Finishing Machine making first trip over concrete after wire mat was placed—men behind finish machine operating longitudinal float—staright edge men on each side of slab behind longitudinal float—belt barely visible at very top of picture.

Fig. 10. Lakewood Covering Machine at Work.
Not quite enough dirt here—shovel men will get spots that are not covered by machine.
Note form crew on left pulling forms directly behind machine.

semblies had been previously marked outside the forms so the groove in the surface of the concrete would be cut in the proper place. After this opening was made, steel plates 2 in. wide and 10 ft. long were slipped into the groove and left in place until the joint was edged.

Following the finishing machine, were the usual finishing operations, with such tools as the longitudinal float, the straight edge, then the bow belt and finally a light canvas belt. (See Fig. 9.) Sides of the pavement and all joints were edged. On this particular job, when the steel plates were removed from the dummy joints, a 2-in. strip of premoulded asphalt was placed in the opening as a filler. Later, after all curing operations were completed, all joints material was cut down below the surface of the concrete, the sides of the openings painted with cut-back asphalt, and the joints sealed with AC-13. When all operations were completed, and just before the concrete was covered with burlap, the surface was again checked with a 10-ft. straight-edge. The concrete was covered with wet burlap, which was left on until the next morning. The burlap was then removed, and the surface again checked for anything that might have been missed in the previous checkings. Ordinarily there was very little revealed by this last straight-edging, other than a few mortar ridges that could be easily scraped off with a shovel. The slab was then covered with dirt and kept wet for a period of 10 days. The allowance under a 10-ft. straight-edge was ⅛ in.

Covering and Curing

A Lakewood covering machine was used to cover the slab with dirt. This machine operated under its own power, and its handling of the dirt was practically the reverse of the subgrade machine. (See Fig. 10.) A series of blades on endless chain belts, and adjustable to fit the amount of material deposited on the shoulders, dragged the dirt to the form line. Here another set of blades, adjusted the required distance above the surface of the pavement, took the dirt from the first set of blades and dragged it across the slab toward the center line. At the same time the machine was moving forward on the forms, thus resulting in an even distribution of cover on the slab. When there was a scarcity of dirt, as was sometimes the case, two men with shovels followed up to cover the scant places.

The machine is equipped with a perforated pipe in front of the blades and about 10 in. above the pavement. A hose is connected to this pipe and the slab is wet just ahead of the placing of the dirt. A crew of hose men follow the machine to wet down the dirt after it has been placed.

With this machine, the previous day's run was usually completely covered by 10:00 or 10:30 in the morning. Since this machine must run on the paving forms, some delay was experienced in getting forms pulled and hauled ahead. However, as soon as the machine started covering, a form crew started pulling forms and loading on trucks or wagons, to be hauled ahead and reset for the day's run. Before dirt was plowed in to cover the sides of the slab, the ends of all expansion joints were checked carefully, to see that the expansion material was "free" and no concrete remained at the ends of the joint.

Final Clean Up.—At the end of the curing period a clean-up crew took care of uncovering the slab, sealing joints, painting center strips, shaping shoulders, planting sod, graveling driveways and intersections, and such other odds and ends as were necessary for the final completion of the job.

The Dual-Drum Paver and Its Operation

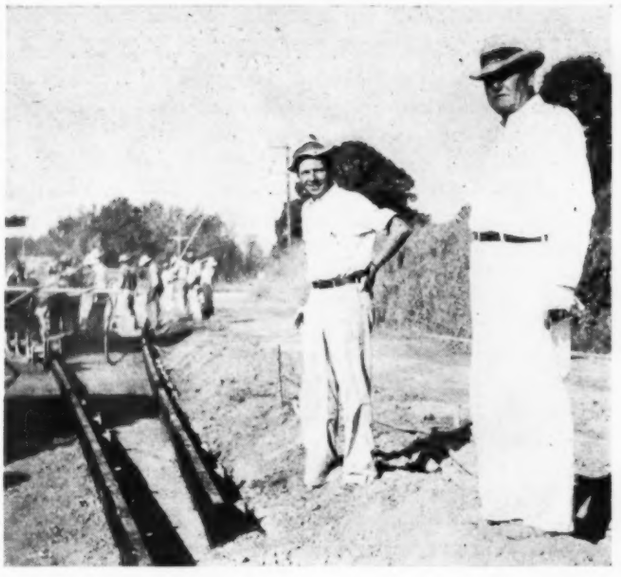
Now for the paver. Outwardly it has the appearance of a standard 27-E built on a larger scale. Of course such features as the boom and bucket, the water tank, etc., must be larger to take care of the material handled in the larger drum. But outwardly there is no dual-drum feature visible: it merely looks like one long drum, which it is. A partition in the middle, making two separate compartments, provides the dual feature; and since it is spoken of as a dual-drum machine, we shall consider it as such.

A chute which operates between the two compartments is supported by an arm extending through the charging end of the drum. This chute, and the chute by which the concrete is discharged into the spreader bucket, are controlled and operated by air. When the mixer is running regularly these chutes operate automatically, all timing being set in the batch meter. However, should it become necessary to operate the chutes outside their regular set timing, there are two hand levers, one for each chute, by which the operator can control them.

For example, all the mixing water is placed in the first drum, and after the material is transferred to the second drum there is no direct way of adding water to the mix. If for any reason the operator discovers he has a dry batch in the first drum, water must be added then or the material lost; but if the paver is allowed to discharge the concrete from the second drum automatically, the operator may not have time to add the needed water to the batch in the first drum before the discharge from the other drum takes place. When the discharge from the second drum is complete, the transfer chute between the two drums automatically opens, and the dry batch might be transferred into the other drum with insufficient water. Even should the operator have had sufficient time to add the water before the discharge took place, such added water would not have been in the mix the required time if allowed to go into the other drum with automatic operation of the chutes. The previously mentioned hand levers make it possible for the operator to control the batch in either of the drums until conditions are satisfactory to get the paver back into the automatic mixing cycle.

Mixing Cycle.—An explanation of the mixing cycle and controls of the dual-drum paver is rather hard to follow without actually seeing it operate. With the aid of the accompanying chart, however, it may perhaps be followed. When this machine was first placed on the job, it might be said still to have been in the experimental stage. It was the first time on the road under actual working conditions. For that reason, and because it was new to everyone on the job, necessitating adjustments in working conditions and methods, no attempt was made in the first day or two to speed up operations! In fact the mixing time on the paver was set so slow that no advantage could be derived from the dual-drum.

Gradually, as things began to get better organized to fit the paver, and timing became better synchronized, the mixing time was also stepped up. This timing finally reached a batch meter setting of 25 seconds, which allowed one minute and 12 seconds for a batch to pass completely through the mixer, with a possible batch every 42½ seconds, with mixer operating at full capacity. This was not maximum capacity under the specifications, which required only a one minute mix, but it was decided that on that timing, concrete could be handled fast enough and the paver kept fairly busy with equipment on hand. If the time was cut down to require just one minute for a batch to pass through both drums, that would produce a batch every 36½ seconds.



On the Job: Ralph Boren, Project Engineer (Left); W. C. Davis, Superintendent Hardaway Contracting Co. (Right).

In order to follow these figures, to get the minimum time interval between batches, divide the specified minimum mixing time, or actual mixing time for one batch, by 2 and add 6½ seconds, giving the following results:

Specified or Actual Mixing Time	Interval between Batches	Time Required for 1 Batch thru Both Drums + Time for Charge & Discharge
60 seconds	36½ seconds	73 seconds
65 seconds	39 seconds	78 seconds
70 seconds	41½ seconds	83 seconds
72 seconds	42½ seconds	85 seconds
75 seconds	44 seconds	88 seconds
90 seconds	51½ seconds	103 seconds

You will notice there are 13 seconds to be taken care of between the actual mixing time and twice the interval between batches. This comes in the transfer from one drum to the other. Take for example, the timing that was finally settled on on this job—one minute and 12 seconds.

The 34-E Dual-Drum Paver at Work near Sandersville, Miss., on Paving Job of Hardaway Contracting Co.

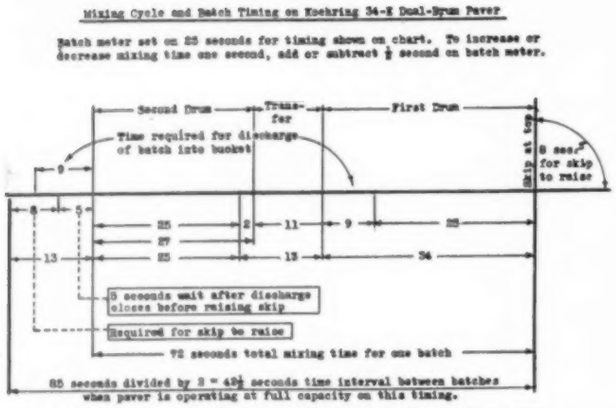

Mixing Cycle and Batch Timing on Koehring 34-E Dual-Drum Paver
Batch meter set on 25 seconds for timing shown on chart. To increase or decrease mixing time one second, add or subtract ½ second on batch meter.
Second Drum
Trans-fer
First Drum
Time required for discharge of batch into bucket
Skip at top
8 secs. for skip to raise
9
8
5
25
2
11
9
25
27
13
25
13
34
5 seconds wait after discharge closes before raising skip
Required for skip to raise
72 seconds total mixing time for one batch
85 seconds divided by 2 = 42½ seconds time interval between batches when paver is operating at full capacity on this timing.

Fig. 11. Mixing Cycle and Batch Timing Diagram.

Also for the present, assume that the mixer has been operating automatically and one batch has just been transferred into drum No. 2. As the skip reaches its top position and material is emptied into drum No. 1 the time lock on the batchmeter is tripped. Twenty-five seconds after the time lock is tripped, the batch in drum No. 2 is started on its discharge into the spreader bucket. This discharge requires 9 seconds. The discharge chute into the bucket closes and the transfer chute between the two drums opens simultaneously. Transfer of materials from No. 1 drum to No. 2 drum requires 11 seconds. Time for starting to raise the skip with the next batch is determined from the time the discharge chute closes and the transfer starts between the two drums. A 5-second signal placed beside the batch meter, easily seen by the operator, tells

27-E---Paver

DAILY REPORT ON MIXER

(Sample copy-- to show enumeration of delays-- Cost data not shown)

Project FAP 123-127 County Jones & Jasper May 28 1937

Size of Mixer 7 bag batch Section Paving 9-6-9 x 20 No. of Batches 442

Constant 3.03 L.Ft./batch Theoretical Ft. Laid 1330 Actual Ft. Laid 1322

Over-run Under-run 17 Stations 811+37 to 824+59

Total time worked 11 Hr. 35 Min. Total delays during working period 1 Hr. 30 Min.

Net time worked 10 Hr. 05 Min. Batches per hr. total time 41 Net time 44

ENUMERATION OF DELAYS

Period From	to	Total Time Hr.	Min.	Cause of Delay
Various			30	No trucks
8:29	8:32		3	Move turntable
Various			19	Water trouble
"			11	Subgrade
9:13	9:16		3	Concrete Cutters
10:32	10:37		5	Reset joint
Total for day		1	30	

	Sq. Yds.	Feet	Batches	Curb
Previous	18529	5636	1890	
Today	8937	1322	442	
To Date	15466	6958	2332	

OPERATING COST

Account	TOTAL Today	TOTAL To Date	UNIT Today	UNIT To Date	Bid per Yd.	No. of Men
Forms & Fine Grade						20
Mixing and Placing						35
Nightwatchman						3
Proportioning Plant						10
Curing						13
Water Supply						4
Total						89

Remarks:

Weather Fair---Hot
Set up at Sandersville, Miss.
No. of Trucks 12
Working Day No. 15

Specimen Daily Report on Work with 27-E Paver.

him when to start raising the skip. This is a small light, so connected with the batchmeter as to form a contact and cause the light to come on just 5 seconds after the discharge chute closes. This 5 seconds, added to 8 seconds required for the skip to raise to its top position, accounts for the 13 seconds between actual mixing time for one batch and twice the time interval between batches.

Returning to a consideration of the transfer from one drum to the other, which required only 11 seconds. Since the 11 seconds started with the closing of the discharge chute, and the 13 seconds (5+8) started at the same time, there is a lag of 2 seconds at that point as a safety factor for complete transfer of materials from drum No. 1 to drum No. 2. The 5-second signal mentioned above, is merely a signal, and nothing else. There is no definite control by locking. It was rigged up on the job after the

34-E-Dual Drum Paver

DAILY REPORT ON MIXER

(Sample copy-- to show enumeration of delays--cost data not shown)

Project FAP 123-127 County Jones & Jasper July 10 1937

Size of Mixer 8-bag batch Section Paving 9-6-9 x 20 No. of Batches 442

Constant 3.46 L.Ft./batch Theoretical Ft. Laid 1589 Actual Ft. Laid 1518.11

Over-run Under-run 16.9 Stations 176+43 to 191+57

Total time worked 10 Hr. 55 Min. Total delays during working period 3 Hr. 12 Min.

Net time worked 7 Hr. 36 Min. Batches per hr. total time 41 Net time 58

ENUMERATION OF DELAYS

Period From	to	Total Time Hr.	Min.	Cause of Delay
7:38	7:45		7	Strike-off cable
Various			28	Cement Dumpers
"			13	Paver Motor
"			33	No Trucks
"			9	Turntable
"			82	Water trouble
11:24	11:39		15	Change Flame
1:17	2:05		48	Subgrade
3:40	4:22		42	Rain-Showers
Total for day		3	12	

	Sq. Yds.	Feet	Batches	Curb
Previous	94207	30806	18908	
Today	3364	1514	442	
To Date	97571	32320	13334	

OPERATING COST

Account	TOTAL Today	TOTAL To Date	UNIT Today	UNIT To Date	Bid per Yd.	No. of Men
Forms & Fine Grade						24
Mixing and Placing						43
Nightwatchman						4
Proportioning Plant						16
Curing						14
Water Supply						5
Total						106

Remarks:
Equation----
188+11.693k = 188+13.78 Fwd.
Minus 1.99 linear feet

Weather Rain PM
Set up at Sandersville, Miss.
No. of Trucks 16
Working Day No. 48

Specimen Daily Report on Work with 34-E Paver.

paver was put to work, and it was discovered that the operators were raising the skip and emptying the next batch of material into the drum in less time than was required for the materials to transfer out of the drum. With all other timings set to the second, it was necessary to give the operator a definite signal by which to start raising the skip. Repeatedly lifting the skip before the preceding batch was completely transferred, would build up material in drum No. 1, and also result in not getting a full batch through drum No. 2 and on into the bucket. In other words, regardless of whether or not all the material had been transferred from drum No. 1, when the skip reached the top position and tripped the time lock, the transfer chute was closed and no more material could pass from drum No. 1 into drum No. 2 until the batch was discharged

Copy--
27-E Paver being used

BATCH REPORT

DATE May-28-1937

													TOTAL
Batches Per Hr.	26	38	34	44	38	40	38	38	38	38	38	30	442 @ 3.03 = 1339
Theoretical Ft. Per Hr.	78	115	103	136	115	121	115	115	115	115	115	91	1333
Actual Ft. Per Hr.	78	114	103	135	114	120	114	114	114	114	114	90	1322
Gain or Loss	-1	-1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	Fractions account for difference between 1339 and 1333

Stations 224+50 to 211+37

Mixer Starts 6:25 Mixer Stops 6:00 Mixer Time 11:35

(429-432 - Truck Idle)(455-457 - No Trucks)(703-705 - No Trucks)(713-715 No Trucks)(777-779 No Trucks)(813-816 Conc. Cutting)
(818-824 No Trucks)(850-857 No Trucks)(935-938 - No Trucks)(998-940 - No Trucks)(1008-1010 No Trucks)
(1014-1016 - Subgrade)(1027-1030 No Trucks)(1032-1034 Contr. Joint)(1108-1111 Subgrade)
(1128-1131 - No Trk)(1203-1209 Subgrade)(1225-1228 - Dry Batch-Last)(1231-1236 Water)
(112-117 No Trucks)(159-203 No Trks)(221-224 No Trucks)(337-345 No Water)
(419-424 No Trucks)(532-535 No Trucks)

TRUCK

Truck No.	1/7	1/8	1/9	1/10	1/11	1/12	1/13	1/2	1/3	1/4	1/5	1/6	Total Loads	Total Batches
35													19	38
37													20	40
32			Each Truck checked and										18	36
34													20	40
28			time noted in these columns										16	32
33													19	38
36			when truck dumps into skip.										15	30
38													17	34
40													21	42
39													20	40
29													19	38
30													17	34
Total	26	38	34	44	38	40	38	38	38	38	30		221	442

Specimen Batch Report on Work with 27-E Paver

out of drum No. 2, and the transfer chute opened again. This of course all refers to the automatic operation of the chutes. The opening of the transfer chute is controlled from the closing of the discharge chute, but the closing of the transfer chute is controlled by the raising of the skip. After the chute is opened to transfer material from drum No. 1 into drum No. 2, it remains in that position until the skip again trips the time lock on the batch meter.

Broad Economic Considerations of the Dual-Drum.—The first thing that is thought of when considering placing a dual-drum paver on the job, is that the production can be increased. That all depends on the other equipment on the job. The main items that will affect the output of the paver, are the linear feet of road forms and the plant equipment. Usually the crane and batcher plant are kept pretty busy supplying a standard 27 paver; and to run the dual-drum paver to capacity this plant would have to be enlarged. Of course more trucks would be required to supply the paver, but since most paving outfits sub-contract their hauling, this would mean that the hauling contractor would have to add more trucks. Practically all other equipment used with the 27-E paver would suffice for the dual-drum paver.

The contractor on this job has taken a rather intelligent attitude toward the dual-drum paver, and is doing some experimenting to establish the practical capacity of the machine on his work and the most economic adjustment of schedules and equipment. Rather than increase plant equipment and get more road forms, he is merely trying to make what was an unusually good day's run with the 27-E paver, an average day's run with the 34-E paver. Although some States limit a 27-E paver to a 6-bag batch, or if using bulk cement, to 29.7 cu. ft., Mississippi allows a 7-bag batch, provided a thoroughly and satisfactorily mixed concrete is obtained. On this job a 7-bag batch was being poured with the 27-E machine, whereas, the 34-E machine handled an 8-bag batch. There was a 15 percent increase right there, without putting any more batches through the mixer. Then the feature of having two batches mixing at the same time made possible an additional increase in production provided the material could be placed at the mixer fast enough. On the timing of this job, with material waiting at the mixer at all times, a batch every 42½ seconds was mechanically possible.

From this it can be seen, that by having the dual-drum paver on the job time lost from minor breakdowns or holdups of any nature can be made up during the day, so that a good day's run will result regardless of the lost time. On this particular job, the contractor realized that he was not equipped to run to full capacity of the paver, but felt that unless he was faced with a complete breakdown for a considerable length of time, he would not have any real bad days due to a series of short losses of time. A comparison of the two pavers used on this job, will in a way bring out this point. Of course everything that may have affected a day's run is probably not brought out in this comparison, but it will give a rough idea of what can be expected. In making this comparison, the first two weeks the dual-drum paver was on the job were eliminated, and the comparison is made over a three week period for each machine.

Notes on Comparative Records of 27-E and 34-E Pavers.—Time lost as shown in these comparative records included mechanical breakdowns, water trouble, subgrade and forms, waiting on trucks, getting equipment across bridges, and other miscellaneous delays that come in a day's run. Man hours were based on the gross running time of the paver, and only on the men employed on forms and fine grading, placing and finishing concrete and at the proportioning plant. Water supply, curing and other scattered phases of the work were not included in this comparison.

It can easily be seen from the comparison of square yards per hour net running time, that a considerable increase in production is possible with the proper equipment to keep the paver pouring. To go further into the time lost during the day, as shown in these comparisons, a sample copy of the report of the time checker on the road, and a copy of the daily report made up in the contractor's office are shown. One day of each report is taken for one of days shown in the above comparison on each paver.

Conditions Affecting Selection of Paver.—Then there are other things to enter into the consideration of the dual-drum paver. Whether or not it would be practical on a

Production Record 27-E Paver—May 24 thru June 12, 1937

Date	Start	Stop	Gross Running Hrs.–Min.	Time Lost Delays Hrs.–Min.	Net Running Hrs.–Min.	Sq. Yds.	Man-Hrs.
5/24	6:15	6:05	11–50	2– 5	9–45	2873	864
25	6:10	6:10	12–00	1–40	10–20	3091	804
26	6:10	6:00	11–50	3–10	8–40	2735	781
27	6:42	6:00	11–18	3–45	7–33	1364 (a)	827
28	6:25	6:00	11–35	1–30	10–05	2938	748
29	7:10	2:36	7–26	0–47	6–39	901 (b)	337
Sub-totals for week			65–59	12–57	53–02	13902	4361
5/31	6:15	6:10	11–55	2–32	9–23	3075	787
6/ 1	6:05	1:25	7–20	0–47	6–33	1949	608
2	No run—wet grade						
3	6:05	6:05	12–00	1–05	10–55	3415	972
4	6:06	6:15	12–09	0–49	11–20	3658	961
5	Norun—Rain						
Sub-totals for week			43–24	5–13	38–11	12097	3328
6/ 7	No run—wet grade from Sunday's rain						
8	6:00	4:32	10–32	1–29	9–03	2811	892
9	10:30	6:10	7–40	0–28	7–12	2284	652
10	6:15	5:40	11–25	0–20	11–05	3554	788
11	7:20	5:46	10–26	1–12	9–14	2919	680
12	6:10	6:00	11–50	0–57	10–53	3486	805
Sub-totals for week			51–53	4–26	47–27	15054	3817
Totals for three-week period			161–16	22–36	138–40	41053	11506

Gross running time—Sq. Yds. per hour.....254.6
Net running time—Sq. Yds. per hour.....296.0
Square yards per man-hour.....3.567
(a) Plus 26.2 Cu. Yds. in approach slabs at ends of bridges.
(b) Plus 26.2 Cu. Yds. in approach slabs at ends of bridges.

Production Record 34-E Dual-Drum Paver—June 28 thru July 17, 1937

Date	Start	Stop	Gross Running Hrs.–Min.	Time Lost Delays Hrs.–Min.	Net Running Hrs.–Min.	Sq. Yds.	Man-Hrs.
6/28	No Run—Rain						
29	6:50	6:00	11–10	2–08	9–02	3425	870
30	6:20	6:00	11–40	2–00	9–40	3678	922
7/ 1	6:30	5:15	10–45	3–13	7–32	3182	871
2	6:05	6:48	12–43	4–26	8–17	3431	931
3	6:15	6:25	12–10	3–12	8–58	3616	973
Sub-totals for week			58–28	14–59	43–29	17332	4567
7/ 5	7:25	1:40	6–15	1–19	4–56	2073	606
6	11:00	6:03	7–03	1–56	5–07	2058	623
7	6:15	6:00	11–45	3–00	8–45	3831	998
8	6:20	6:00	11–40	2–58	8–42	3762	1034
9	No Run—Rain						
10	6:05	5:00	10–55	3–19	7–36	3360	913
Sub-totals for week			47–38	12–32	35–06	15084	4174
7/12	6:25	6:00	11–35	3–19	8–16	3606	1127
13	6:35	5:00	10–25	2–10	8–15	3176	945
14	6:17	5:50	11–33	5–10	6–23	2849	839
15	6:05	1:32	7–27	0–36	6–51	2940	682
16	6:15	6:10	11–55	1–59	9–56	4504	876
17	8:00	4:45	8–45	2–53	5–52	2740	840
Sub-totals for week			61–40	16–07	45–33	19815	5309
Totals for three-week period			167–46	43–38	124–08	52231	14050

Gross running time—Sq. Yds. per hour.....311.4
Net running time—Sq. Yds. per hour.....420.7
Square yards per man-hour.....3.717

job might depend on typical sections of the slab, specified mixing time of the concrete, amount of reinforcing and joints to be installed, and other items of like nature. For example, for a 7-5-7 pavement, which is poured in some states, carrying wire mesh reinforcing, dowel assemblies, center steel and tie-bars, and poured on one minute mixing time, it is doubtful if the dual-drum paver would prove of much advantage. The volume of concrete per linear foot of roadway, would be so small, that an 8-bag batch poured anywhere near as often as possible with this paver (maximum possibility—a batch every 36½ seconds), would probably be placing the concrete faster than the handling of the steel and the finishing operations could be taken care of. On the other hand, where thicker pavements are poured, and on longer mixing times, these follow up operations are more than likely waiting on the paver. For example, with a typical section slab of 9-7-9 paving on a 1¼ minute mixing time, the dual-drum paver would no doubt prove a big advantage. There are a number of states that require a mixing time of 1¼ and 1½ minutes, and one state even requires 1¾ minutes mixing time. Somewhere, in between these extremes, there will more than likely be determined a dividing line about which the dual-drum paver will prove either practical or impractical.

All in all it seems the dual-drum paver is here to stay; but due to the several conditions previously mentioned, there is still the question as to just where it is going to prove to the best advantage. From a mechanical and from a production standpoint, it is another step forward in road building, and there seems to be ample reason to believe that paving contractors, doing work in states or sections of the country where it can be used to an advantage, will begin gradually to build up to the larger mixer.

Copy—
34-E-Paver being used

BATCH REPORT

DATE July 10 1937

													TOTAL
Batches Per Hr.	60	44	46	52	52	36	46	18	42	30	12		442
Theoretical Ft. Per Hr.	291	152	157	174	180	124	159	62	146	104	41		1529
Actual Ft. Per Hr.	264	157	159	172	179	129	157	64	148	109	40		1514
Gain or Loss	-2	-1	-1	-2	-2	-2	-2	-1	0	-1	-1		
Stations	176+43 – 191+57												

Mixer Starts 6:05 Mixer Stops 5:00 Mixer Time 10 –55

(352-304 Conc. Pavement) (314-313 Conc. Pavement) Delays (325-330 Mixer Repairs) (338-345 Waiting for Concrete)
(317-321 No Trucks) (321-328 Mixer Repairs) (332-340 No Trucks) (343-345 No Trucks) (349-351 No Trucks)
(351-353 No Trucks) (349-352 No Trucks) (354-356 Grout) (356-359 Conc. Pavement) (357-358 Mixer Repairs)
(359-359 Change Plans) (353-356 No Mix) (359-12:13 No Mix) (12:20-12:25 No Mix) (12:32-12:38 No Mix) (12:57-1:01 No Trucks)
(1:10-1:19 No Trucks) (1:7-2:18 Trucks cut off – Subgrade and forms not far enough ahead of paver)
(2:11-2:15 Mixer Repairs) (2:29-2:41 No Mix) (2:52-2:55 Mixer) (3:01-3:20 Mixer Repairs) (3:44-3:45 Trucks cut off – Showers) (4:38-4:42 – wait for last truck and header) Rain

TRUCK

Truck No.	6/17	7/8	8/9	9/10	10/11	11/12	12/1	1/2	2/3	3/4	4/5		Total Loads	Total Batches
38													15	30
28													15	30
37													14	28
40			Each truck checked and										15	30
35													13	26
36			time noted in these columns										14	28
29													13	26
31			when truck dumps into skip.										14	28
30													13	26
33													14	28
39													14	28
26													14	28
34													15	30
32													14	28
25													12	24
27													12	24
Total	60	44	46	52	52	36	46	18	42	30	12		221	442

Specimen Batch Report on Work with 34-E Paver.

THE MODERN HIGHWAY BRIDGE

As Expressed by Recent Designs of the California Division of Highways

BY LEONARD C. HOLLISTER

Assistant Designing Engineer, Division of Highways, California Department of Public Works

THE extensive use, throughout the country, of the continuous and rigid frame type of structure has led to the development of many interesting and unusual bridge designs. These more modern conceptions are nearly all accompanied by two desirable qualities, beauty and economy. While we have not yet developed any of the daring expressed by the bold, slender arches with their graceful symmetry, recently developed in France, yet the numerous articles being published in our engineering magazines describing many ingenious and beautiful bridge designs, give evidence of a profound advancement being made in the art of architecturally fine bridges.

Figures 1, 2 and 3 are typical examples of the architectural trend for modern highway structures. Simplicity seems to be the keynote, with a complete lack of decoration or adornment, relying solely on proper proportions and graceful lines for beauty. The structure must be viewed and judged as a whole; nothing is superfluous or redundant, yet nothing is wanting. Thus the engineer and the architect have approached each other's viewpoint more closely than has ever before been the case. Wanton waste of materials for decoration appears to the engineer as inefficient and to the architect as common without taste.

This viewpoint has been clearly expressed by Alfred Eichler of the Division of Architecture, of the California Department of Public Works, as follows:

"At one time it was thought that architectural design of bridges and engineering structures consisted in adding various architectural elements such as moldings, cornices, brackets, pilasters and the orders of architecture to a framework previously devised by the Bridge Engineer. This procedure is in error because, in the first place, it represents the addition of a lot of useless falsework and gingerbread having no relation to the structure. Secondly, the structural requirements of the bridge and the requirements essential to traditionally correct forms in applied architecture in most cases did not coincide, resulting in an inevitable detriment to the artistic composition. The trend was then towards the use of elements of free design not based on any historic precedent, only to be counted out again for the first reason as above—that these forms are still applied forms unessential and a needless expense and without structural relation to the bridge, being constructed decoration, like so much stage scenery, and with still another reason—that these forms of free design are transitory, are definitely dated, and go out of fashion, the same as the style in women's hats. Forms which to one generation are an aesthetic embellishment become an architectural excrescence to the next generation. We are justified, no one will deny, in so permanent a structure as a bridge, to design for the long haul, to attempt something that will not only please contemporary tastes, but will be good for all time. The elements that do not change are good proportions, pleasing lines and graceful curves, plain masses expressive of sound construction and, above all, simplicity. These factors are timeless."

These sketches are all studies for highway separations;

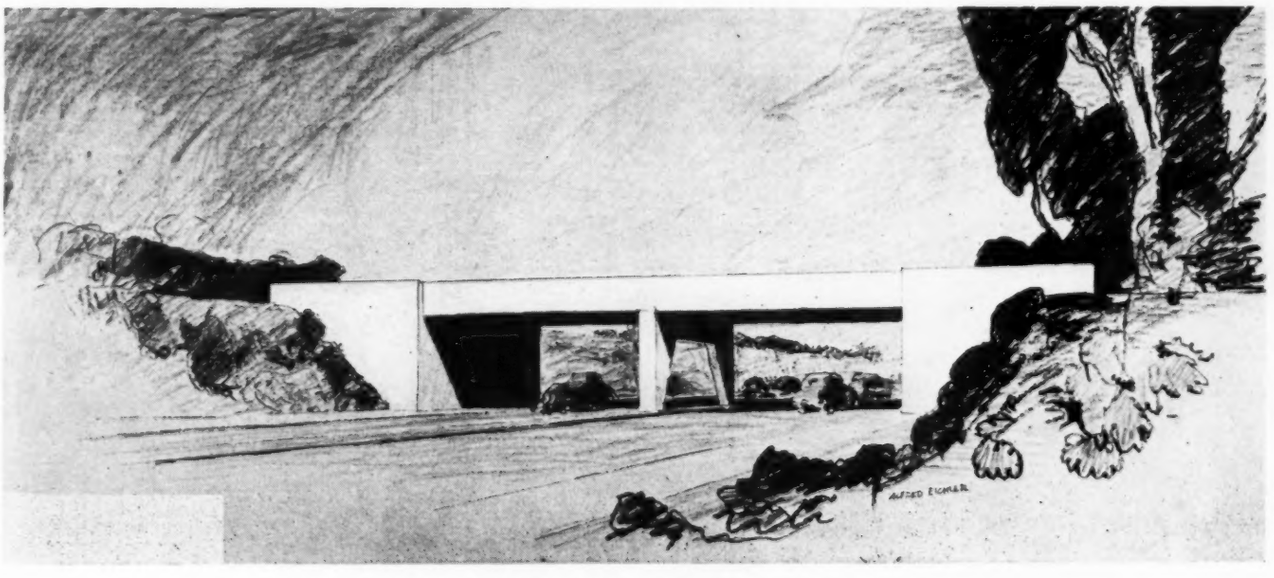


Fig. 1.—Architectural Study of a Highway Separation Structure.

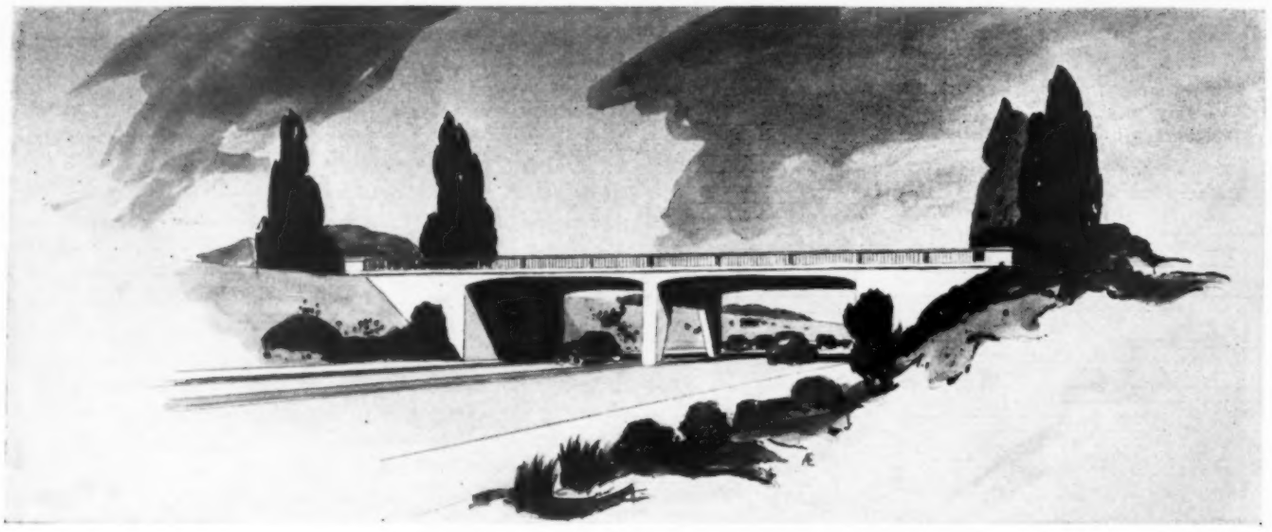


Fig. 2.—Architectural Study of a Highway Separation Structure.

Figures 1 and 2 are studies for the same separation. The first is more simple in detail and is probably a true expression of the architect's conception of symmetry. The second is a development for the same structure with an open type of railing. The third study is for a separation crossing two highways and a canal with a large skew. Here the physical requirements are awkward and architectural treatment is difficult. The center span is 118 ft. and the two side spans 75 ft. The deck is composed of two 35-ft. roadways with a 6-ft. dividing strip and two 5-ft. sidewalks.

The advantages of this modern style over the simple span type of structure have so often been stated that it seems of practically no purpose to once again repeat them, yet there still exists skepticism in the minds of many. There are some who believe the benefits gained are not worth the additional time and effort required for the design; others feel that the indeterminate nature of the stresses may lead to faulty design or construction. A few express apprehension as to the results of settlement and movement as might be caused by earthquakes or other disturbances.

It is believed that the knowledge gained from the many structures which have recently been built, gradually will dispel the doubts now existing. It is true that the indeterminate nature of these designs calls for more care and skill on the part of the engineer, yet these bridges properly designed and constructed are by far the more desirable. They are more resistant to seismic and horizontal forces, for it is believed generally that with the proper details, the more unified the structure the more aseismic the design. By the careful analysis of temperature stresses these structures make possible the elimination, or at least the reduction, of expansion joints, which have always proved a source of trouble in any structure.

It is hoped that the sketches and descriptions contained in this article will give the reader a picture of the many situations and conditions to which this type of structure

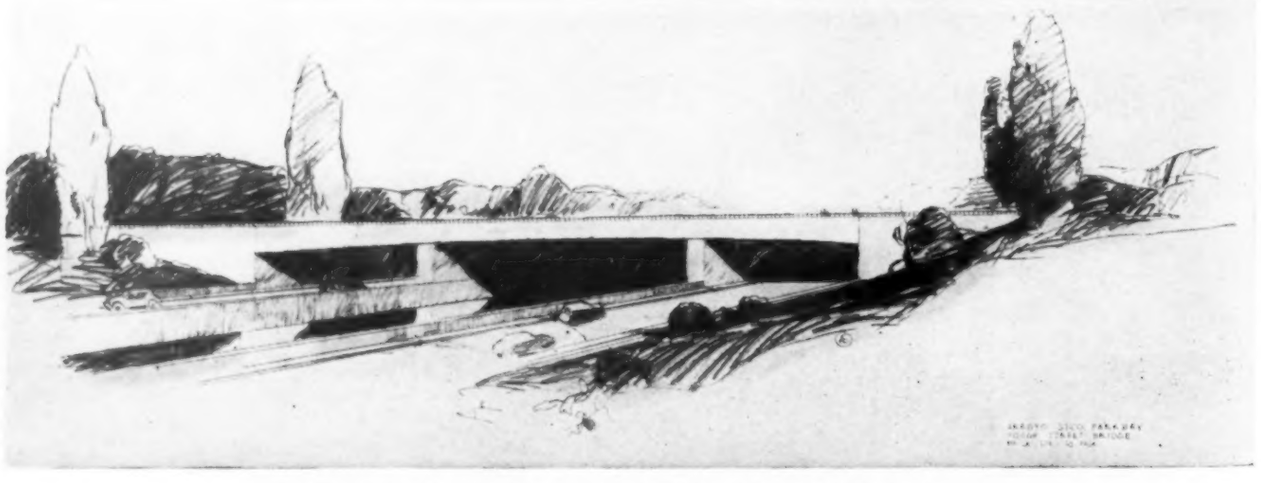
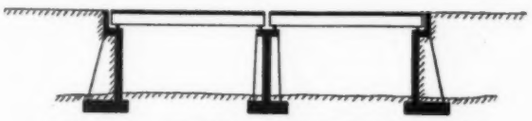


Fig. 3.—Architectural Study of a Highway Separation Structure.



SIMPLE SPAN CONSTRUCTION

1 - EXPENSIVE ABUTMENTS
2 - TROUBLESOME EXPANSION AND BEARING DETAILS
3 - CLUMSY GIRDERS WITH LITTLE RIGIDITY
4 - LITTLE HORIZONTAL RESISTANCE TO EARTHQUAKE FORCES
5 - AWKWARD IN APPEARANCE

CONTINUOUS FRAME CONSTRUCTION

1 - INEXPENSIVE ABUTMENTS
2 - NO EXPANSION OR BEARING DETAILS
3 - THIN SLAB SECTIONS GIVING MAXIMUM CLEARANCE WITHOUT LOSS OF RIGIDITY
4 - MAXIMUM HORIZONTAL RESISTANCE TO EARTHQUAKE FORCES
5 - GRACEFUL LINES PLEASING IN APPEARANCE

Fig. 4.—Sketch of simple span versus continuous frame construction.

so readily lends itself with grace and economy. It is possible from these designs and others throughout the country, that there will evolve a new concept of bridge design, which will be expressed by structures even more beautiful and graceful, without loss of economy.

Figure 4 gives a graphic comparison between the modern frame type structure and the old simple span style.

Figure 5 shows an architectural sketch of Webber Creek Bridge and Figure 6, the principal dimensions. Here the designer has succeeded in bestowing the structure with graceful lines of pleasing proportions. It will also be noted how the awkward situation of the high fills at the ends of the bridge is effectively overcome by the use of "floating" abutments. The end spans are hinged at a point 21 ft. out from the piers, relieving the structure of any damage due to possible settlement of the high fills. Provision has been made at the abutments for jacking the girders back to grade, if required. The hinge is located at such a point as will cause the negative moments over the end piers, due to the cantilever action, to be approximately equal to the negative moments over the center pier. Thus the reinforcing steel for the three spans can be made almost identical, keeping to a minimum the shop

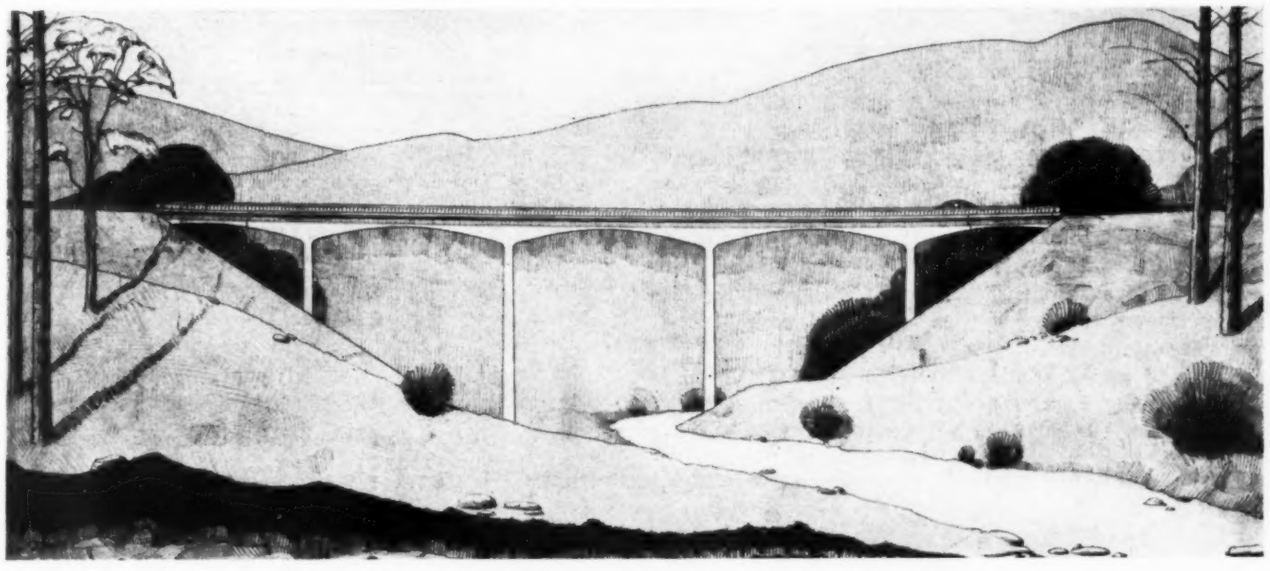


Fig. 5.—Architectural sketch of Webber Creek Bridge.

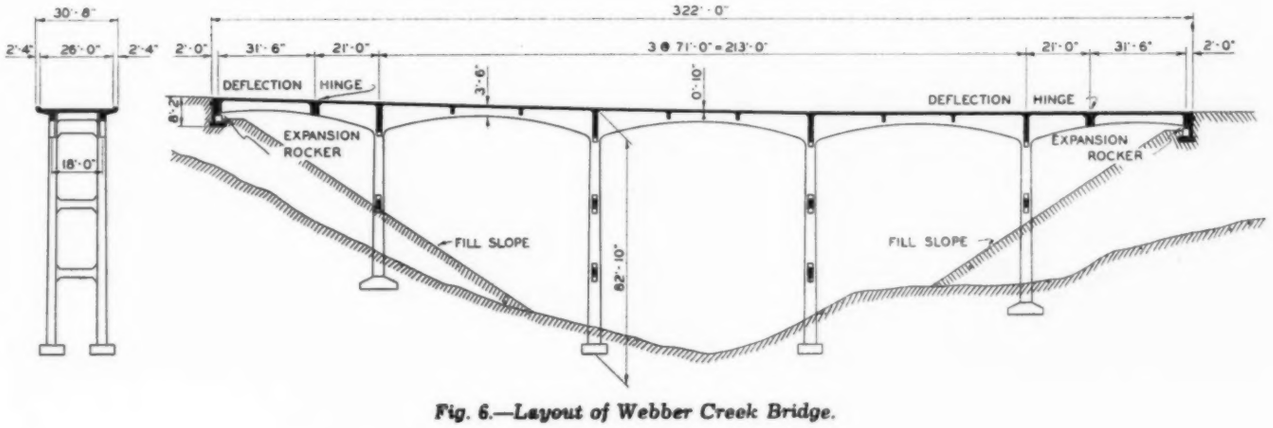


Fig. 6.—Layout of Webber Creek Bridge.

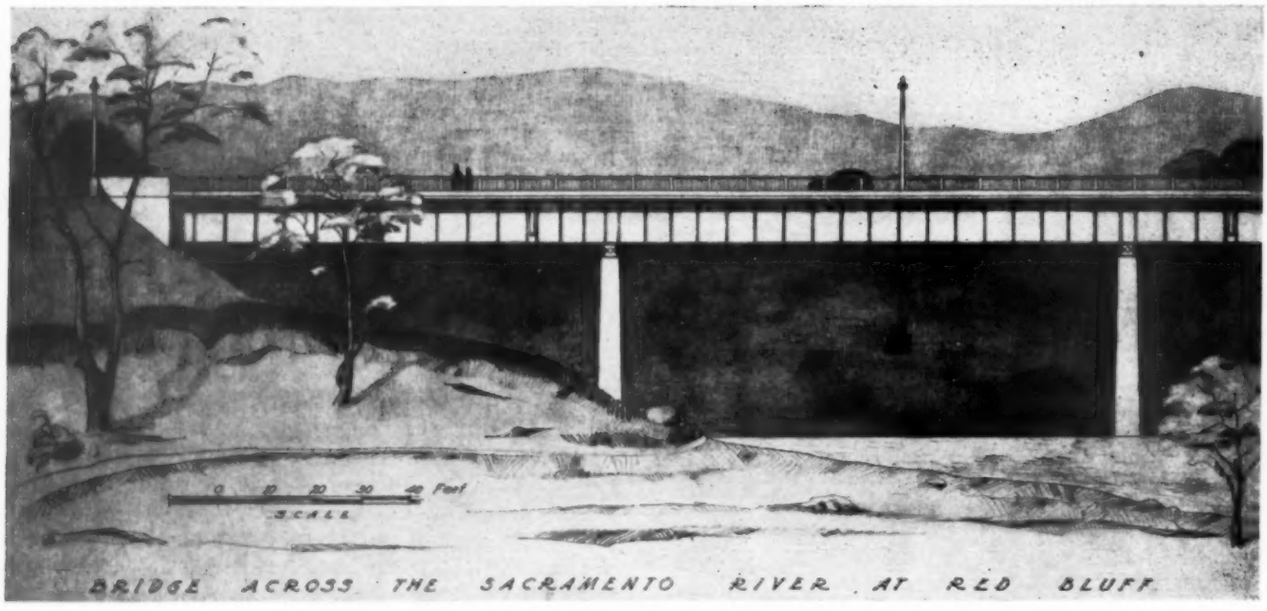


Fig. 7.—Architectural sketch of Sacramento River Bridge At Red Bluff.

details and fabrication. Here it will be noted that the height of the columns has made it possible to eliminate all but the two expansion joints at the abutments where the girders rest on steel rockers.

An architectural sketch of the Sacramento River Bridge at Red Bluff is shown in Fig. 7. Here the designer has given to the structure a pleasing symmetry by the use of unusually plain and simple details. The slender piers without caps or copings are made possible by the continuity of the girders with expansion details located in the spans away from the piers. Figure 8, showing the span lengths and main dimensions, gives a graphic illustration of the economy effected by the reduction in moments over a simple span design.

A design for the Salinas River Bridge at Soledad is represented by Figures 9 and 10. This concrete design embodies many of the ideas expressed by the steel girder

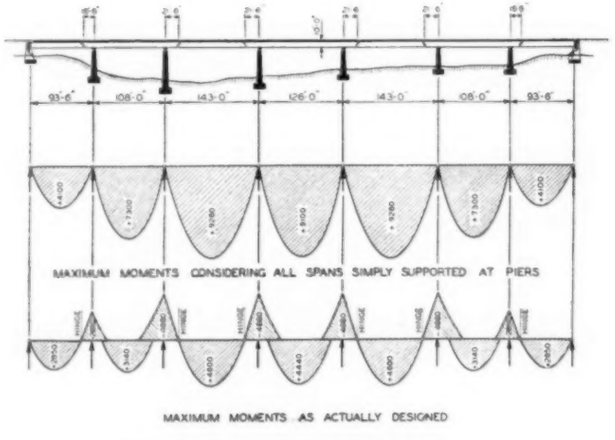


Fig. 8.—Moment diagram for above.

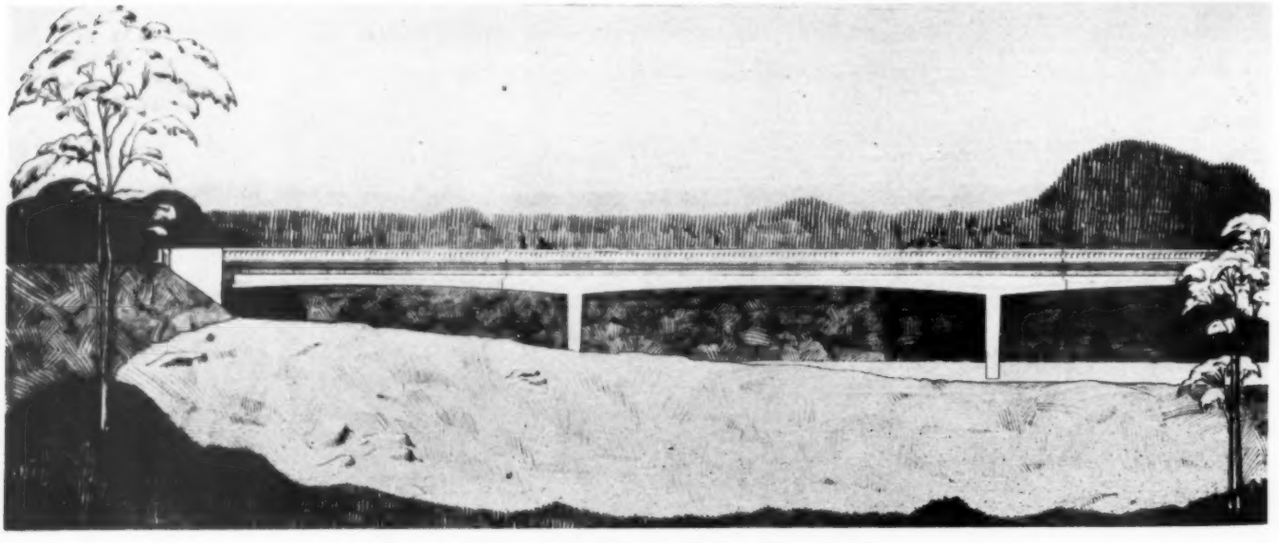


Fig. 9.—Architectural sketch of Salinas River Bridge.

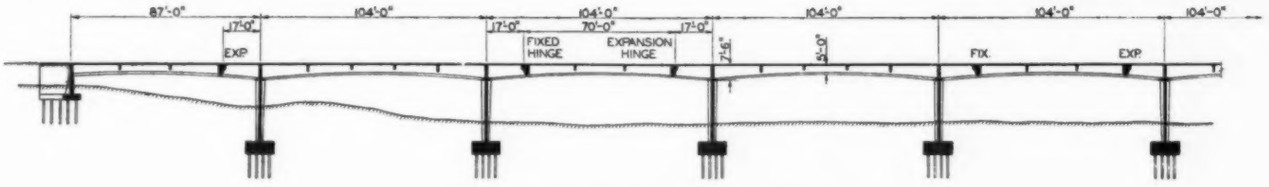


Fig. 10.—Layout of Salinas River Bridge.

design for the Sacramento River Bridge. In this structure the piers are tied together in units of two and each unit designed as a frame with the piers hinged at the bottom. The total length of the structure is 1530 ft. Here, as at Red Bluff, it was desirable to maintain the maximum clearance above high water. The aesthetic possibilities are also apparent from the architectural sketch. Observe the absence of customary rail posts at the piers. They seem here to have no relation one to the other and are much better left off, giving a more uniform continuous flow of line.

Somewhat different are the two structures across San Gabriel River and Warm Creek shown in Figures 11 and 12, respectively. Here the suspended spans have been eliminated and only expansion hinges used to relieve temperature stresses. This has the effect of extending the continuity of the structure from one end to the other with a more uniform balance of moments throughout. In both of these structures the moments in the end spans are relieved by the end cantilevers, maintaining moments approximately equal to the interior spans. The cantilevers here also eliminated the necessity of abutments. In the San Gabriel River design a soffit slab has been used to increase the resistance of the beams in the region of high negative moments near the supports.

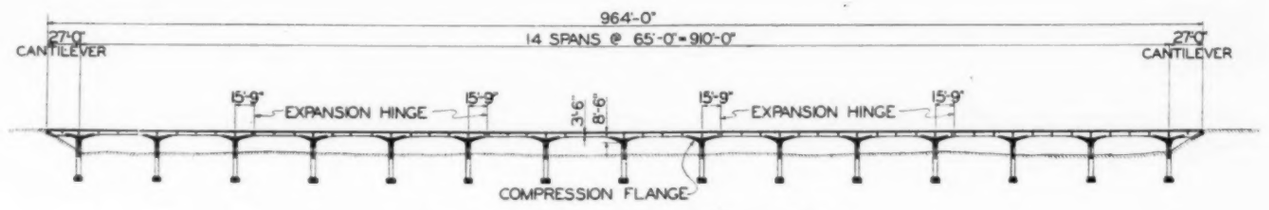


Fig. 11.—Sketch of San Gabriel River Bridge.

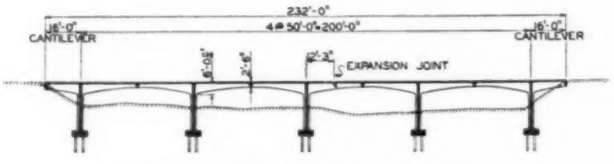


Fig. 12.—Sketch of Warm Creek Bridge.

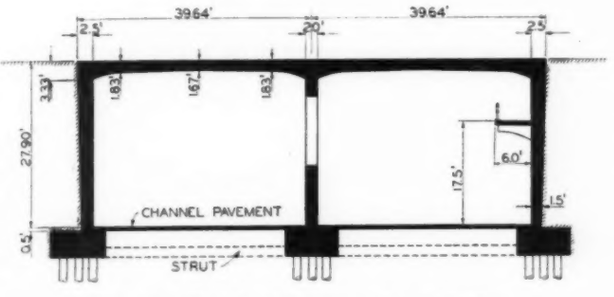


Fig. 13.—Sketch of Topango Creek Bridge.

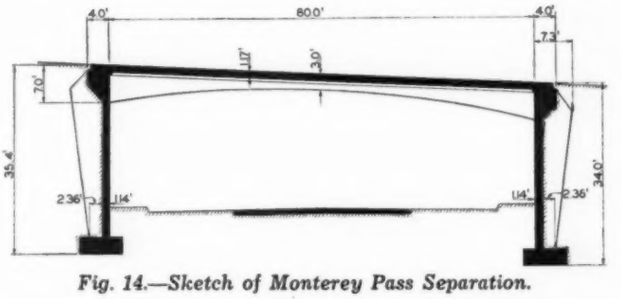


Fig. 14.—Sketch of Monterey Pass Separation.

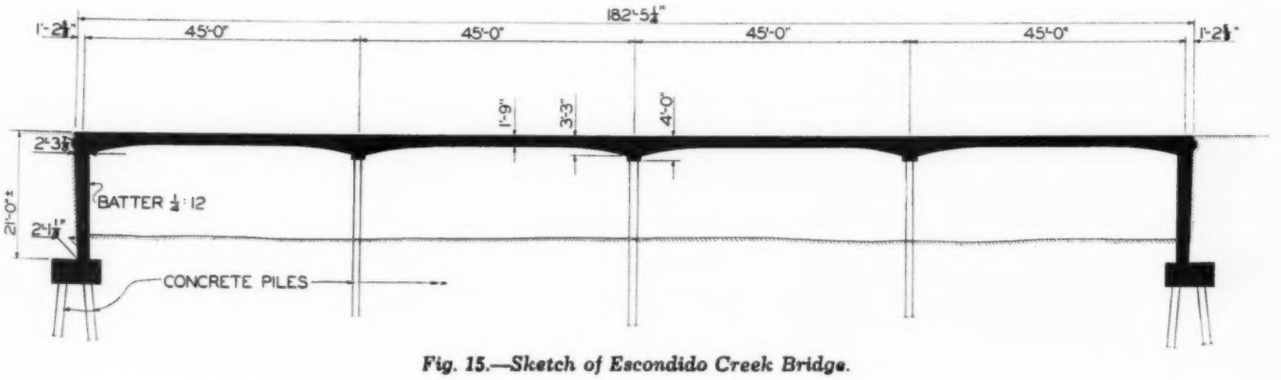


Fig. 15.—Sketch of Escondido Creek Bridge.

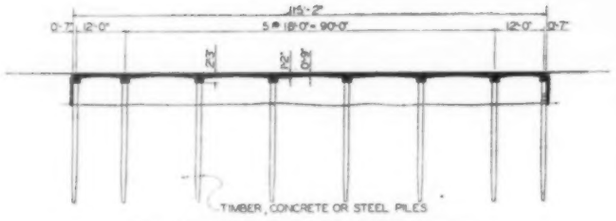


Fig. 16.—Sketch of short slab spans.

Figure 13 is a sketch of a structure at Topango Creek. It was desirable to carry pedestrian traffic under a wide, busy highway at this location. The thin concrete slab frame made it possible to maintain headroom for pedestrians above high water. The structure rests on timber piles and has horizontal struts between footings to take the thrust due to earth loads. The channel is also paved to prevent scour.

A typical separation between two main highways is shown in Figure 14 for Monterey Pass. The maximum headroom is here made possible by the frame type of construction.

The continuous slab or slab frame is most frequently used where the utmost clearance is desired. Figure 15 shows a series of four 45 ft. slab spans offering a minimum of obstruction to the flow of water at Escondido Creek. The structure is supported on concrete piles and there are no expansion joints throughout its entire length of 182 feet.

Figures 16 and 17 show short span slab designs which have been developed as a permanent type structure having a low first cost. Figure 17 represents one unit of a bridge across Sutter-By-Pass which has a total length of 4240 ft.

While the arch is one of our oldest types of structures it still occupies a very prominent place in our modern day bridges. It probably lends itself to architectural treatment with more ease than any other type of structure.

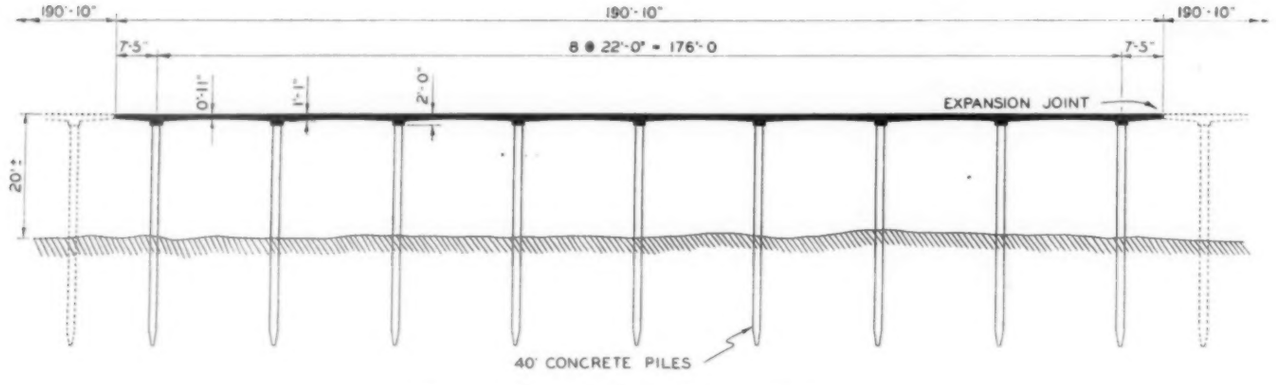


Fig. 17.—Sketch of Sutter-By-Pass Viaduct.

The arch will always be a thing of beauty and grace.

An arch of unique design has been developed for Big Creek, illustrated by Figures 18 and 19. Here a not uncommon yet difficult situation exists. The canyon bed is composed of good foundation material capable of resisting many tons of pressure while the canyon sides are com-

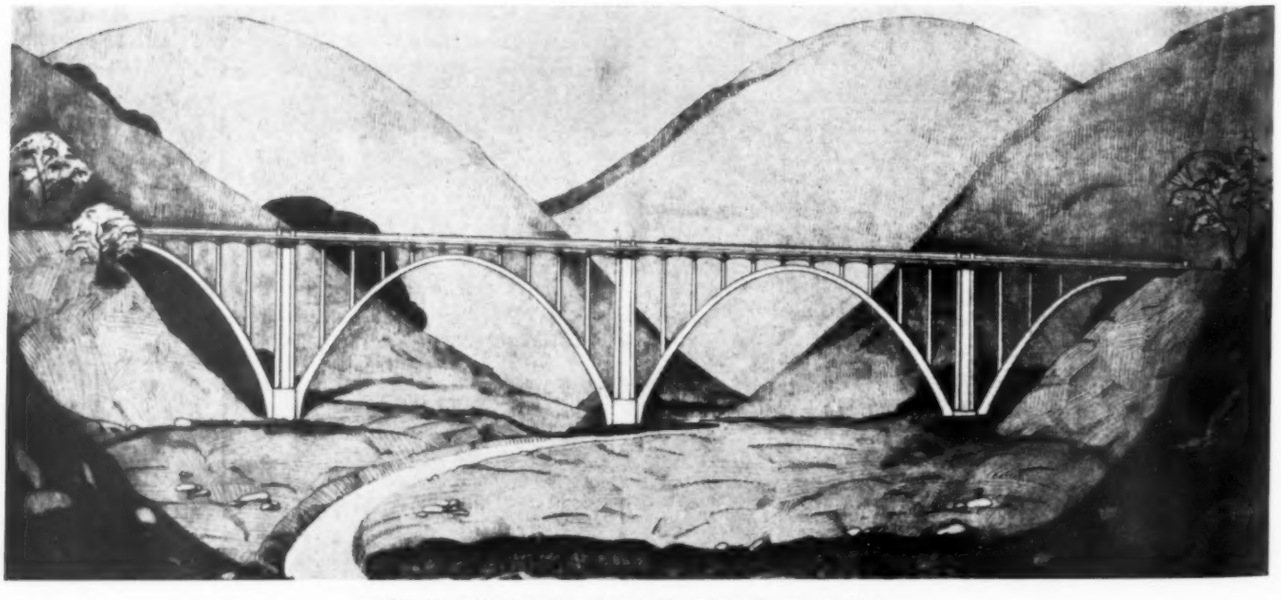


Fig. 18.—Architectural Sketch of Big Creek Bridge.

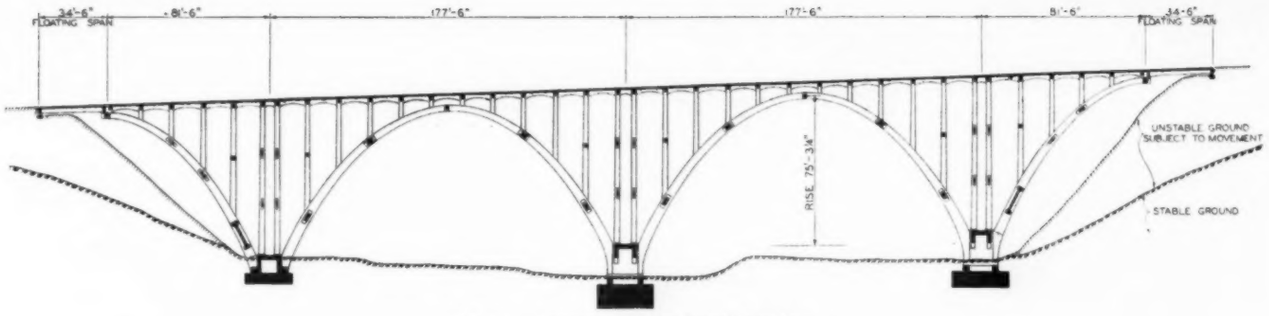


Fig. 19.—Layout of Big Creek Bridge.

posed of a heterogeneous material subject to slipping and movement. Once again the floating abutments and end spans have been used to free the structure from any deleterious effect that might be caused by the sliding of the canyon walls. The floating end spans are supported by half arches, cantilevered out from the end piers. The two half arches are tied together through the superstructure and the three piers are designed to take any unequal thrust that might be caused by live loads.

It is not intended that the reader should conclude from the above article that there is no place for the simple span structure or that it is no longer used. There are still many times and places where conditions make it become judicious to use the simple span concrete girder, steel girder or truss. While they, too, have undergone many improvements in the last few years, the greatest change has been in the development of the rigid or continuous type of structure.

Competition to Secure Designs for Elevated Highway

The American Institute of Steel Construction has announced a national competition for the most suitable structural and architectural design of an elevated highway. The designs must be submitted not later than March 31, 1938. The first prize is $5,000; second prize, $2,000; third prize, $1,000; ten honorable mention awards, each $100.

The object of the competition is to develop a technique of design suitable to elevated highways. The competition will be judged on the originality of design, practicability of construction, the economical use and arrangement of materials, adaptability to actual conditions, and beauty. Designers may feel free to use new methods of design, new materials, and color if they so elect.

The technical conditions controlling the designs are as follows:

1. The structure shall be designed for an "H-20" loading, as a maximum, but any competitor may design for the exclusive use of passenger automobiles based upon such load factors as he may propose, provided that one "H-20" truck shall be assumed to be on any one span, with a congested load of passenger automobiles. The actual size of steel members need not be given. The loadings are given merely as a guide for proportioning materials and fixing construction limits.

2. The design shall provide for two 11-ft. operating lanes in each direction, physically separated and with adequate outer guard rails, but any competitor may submit additional designs providing for three or more operating lanes in each direction.

3. The structure shall be designed to be built over existing thoroughfares. Any type of support may be used, provided, however, that if supports are placed in existing roadways they must not interfere with the free flow of surface traffic. The competitor may pick out some actual site in his own community and develop a design to meet actual conditions.

4. Structures designed to pass over existing surface traffic shall provide for a free and unobstructed clearance of 15 ft. between the bottom of the elevated structure and the pavement of the street below.

All structural members shall be of steel. Other parts may be of any material suitable to the design. Further particulars of the competition may be obtained from V. G. Iden, Secretary of the Institute, 200 Madison Ave., New York City.

▼

Road Oil Sales in 1936 Were 21 Percent Over 1935

Sales of road oil in 1936 showed a gain of 1,457,758 barrels, or 21 percent, over 1935, according to the U. S. Bureau of Mines. California produced approximately one-third of the 8,256,694 barrels of road oil sold last year, having a value of $10,427,208.

Increased construction of low-cost bituminous roads in many states is resulting in a growing demand for road oil and asphalt. Last year asphalt sales increased 30 percent. According to the American Association of State Highway Officials, the following mileage of bituminous roads, involving the use of road oil or asphalt, were completed last year:

Type	*Mileage*
Bituminous treated sand-clay	494
Bituminous treated gravel	3,268
Bituminous treated macadam	783
Low-cost bituminous mix	6,243
Bituminous macadam	695
Bituminous concrete	905
Other bituminous treated types	1,005
TOTAL bituminous roads completed	13,393

Mileage of bituminous roads completed during the year constituted 75 percent of all road construction of a type higher than gravel. During 1936 a total of 32,635 miles of road were improved. Besides the 13,393 miles of bituminous types of roads, there were built 8,455 miles of gravel, 462 miles of sand-clay, and 657 miles of macadam roads. Grading and draining of 5,919 miles of earth roads was also completed during the year.

If You Were Not at

The MONTANA NATIONAL

In the Midst of Such Scenery the Delegates Settled Down to a Highly Efficient Discussion of Bituminous Road Problems. Looking Across Swift Current Lake to Many Glacier Hotel, Where the Conference Was Held.

By J. C. B.

HAVING three times demonstrated its hospitality, Montana now relinquishes its position as host to the annual bituminous conference. The place of next year's meeting has not been decided, but wherever it is, some one will have to step wide and handsome to hold the established standard.

The 1937 meeting, September 7, 8 and 9, in Glacier Park, was a merger of Montana Bituminous Conference and National Road Oil and Asphalt Congress, with Montana State Highway Department and Western Petroleum Refiners' Association looking after the heavy work of planning and management. And if you don't think it was heavy, you just don't know the innards of such things.

Another View on Going-to-the-Sun Highway. This Main Road Through Glacier Park Was Built by United States Bureau of Public Roads and Is Patrolled by Courteous Park Rangers. It Is Not Fool-Proof but Is Perfectly Safe for the Reasonable Driver. Most Delegates Took This Trip at Least Once, and All Hope to Take It Again.

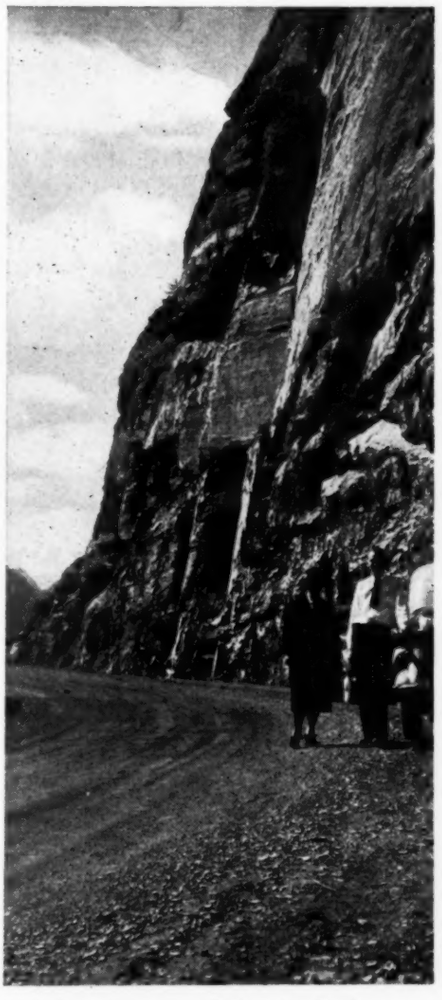
Going-to-the-Sun Highway Takes Us by Lovely Lake St. Mary and Over the Continental Divide at Logan Pass—Elevation 6654 Feet. Surrounding Peaks Are Close to the Ten-Thousand Foot Mark—Some a Little Above It. Total Length of this Highway from St. Mary on the Easterly Park Boundary to Belton on the Southwest Is Fifty-three Miles.

BITUMINOUS CONFERENCE *You Missed a Lot*

To General Chairman D. A. McKinnon, Montana State Highway Engineer and his assistants, D. L. Cheney, Montana Bituminous Engineer, and G. E. Everett of the Western Petroleum Refiners' Association, goes first credit, naturally and properly; but along with these three were members of the Montana Highway Department staff, Montana Contractors' Association, Montana Petroleum Refiners, committee chairmen and others, without whose efficient and wholehearted cooperation the great success of the meeting would have been impossible. Sorry we haven't space for all their names. A special word, however, must be said for the refiners and contractors, for it was they who supplied the principal entertainment features—rodeo, scenic trips for the ladies, pow wow and banquet. And did they do things right!

Acknowledgment also must be made of the exceedingly courteous cooperation of the U. S. Weather Bureau, who, by special arrangement with the committee, supplied their very finest brand of early fall stock continuously from start to finish.

Ho hum! It was a spacious night last night, but we gotta get down to work. And take it right now from one who was present primarily as an observer, that we did get down to work in astonishingly efficient fashion—the most efficient, in fact, of the numerous conventions he has attended. Possibly it was the mountain air or perhaps (well, pick your own reason) but the usually inarticulate tribe of engineers loosened up in a way that would have done credit to a convention of salesmen or school teachers; and almost every session was closed with members still eager to talk. Attendance was always good, in spite of temptations to sleep or go fishing. The papers and discussions deserve more attention than can be given here. Following last year's precedent, each chairman presented a review, or synopsis, of papers submitted in his section, these reviews forming bases for the succeeding discussions. Some of them will be printed in future issues of ROADS AND STREETS. It would, perhaps, be unwise to prolong these conferences beyond the usual three days, but one can not avoid regret for the discussions that might have been.



A Sharp Turn on Going-to-the-Sun Highway.

After the Conference We Lingered to Enjoy the Park. This Group Is Looking through an Observation Opening in Wall of Logan Pass Tunnel. Left to Right—Mrs. Nan Powers, Publishing Director, Powers' Road and Street Catalog, Miss Mary Morris, Montana Highway Department, Mrs. B. F. Osterholm, Powers' Road and Street Catalog, Mr. R. M. Flaherty, Montana Highway Department.

Initiation of Conference Members into the Blackfeet Tribe. These Gentlemen Are Now Chiefs and May Be Addressed as Follows—Bernard E. Gray, Chief Two Suns; A. V. Bourque, Chief Boy Chief; F. C. Lang, Chief Bear Chief; F. V. Reagel, Chief Glacier; H. H. Houk, Chief Rising Wolf; G. A. Draper, Chief Three Stars; A. B. Nuss, Chief Mountain Bear; B. L. Boye, Chief Red Mountain; W. W. Zass, Chief Big Lake.

A full session of the conference was devoted to each of the following four subjects—

Research Correlation and the Development of a Bituminous Bibliography.

Developments in the Fundamentals of Bituminous Construction.

Developments in Practical Design and Construction of Bituminous Surfaces.

Maintenance of Bituminous Surfaces.

Each subject received broad and liberal treatment, with little dogmatism and a free acknowledgment that on almost no point in the whole bituminous field has the final word been said. Reports from different sources developed numerous instances in which excellent results (equally good so far as might be judged) were obtained with widely different designs, construction methods, or maintenance methods. Inference: Don't get too cocky when you do a little better than the fellow in the next county.

Throughout the technical discussions one thought proved its importance by coming out again and again—sometimes in quite unexpected connections. *An adequate foundation and base course are the first requisites for any bituminous road, and must receive better attention than they have commonly received in the past.* The case is a good deal like that covered by the flower gardener's maxim, "It's better to put a fifty cent plant in a five dollar hole than a five dollar plant in a fifty cent hole."

Among program features not primarily related to bituminous roads was the initiation of nine members of the Conference into the Blackfeet Indian Tribe. The ceremony followed the main events of the rodeo, and several hundred palefaces watched with interest as their comrades were made chiefs and received new names. But don't expect too much from a name—even an Indian name. For example, Chief Three Stars (otherwise G. A. Draper, Mississippi Research Engineer) refuses all guarantees of the pleasing suggestion carried. Perhaps some of his friends were lucky not to be dubbed Chief White Horse or Chief Four Roses.

As a fitting supplement to the conference, representatives of the Montana Highway Department, the asphalt companies and the contractors, who had so successfully combined their efforts in the interest of the meeting, took a large number of out-of-state delegates on extended tours over some of the bituminous roads of which they are so justly proud.

Oh, yes. We most forgot the statistics. Total registered for the conference, 265. Total attendance, including delegates' families not participating in conference, 367. Beside representatives from most of the states, there were delegates from Mexico, Alberta, British Columbia, Manitoba, and Ontario.

▼

Standard Specifications for Public Works Construction

For many years the American Society of Municipal Engineers had as one of its major activities the formulation of Standard Specifications for the construction of various types of municipal improvements. A revision and assembly of those specifications, as of 1936, has just been published by the American Public Works Association, a consolidation of the American Society of Municipal Engineers and the International Association of Public Works Officials.

These specifications are intended to serve the public works engineer as guides or models for the preparation of actual contract specifications. They are not intended to be incorporated bodily in any set of contract documents. Local conditions, with which only the engineer responsible for a specific project can be familiar, must always be given full consideration and the specification modified accordingly when necessary. However, when used as guides, these specifications will enable the specifying engineer to be confident that no essential item is overlooked and that the materials and construction methods specified conform to good practice.

The present edition consists of twenty-two specifications in the field of street paving. There are nine dealing with pavement foundations, two with sidewalks and curbs, one with brick pavements, one with stone block pavements, and nine with bituminous pavements. The specifications for portland cement concrete pavements and for sewer construction are now being revised and will be given publication in the same format in the near future.

The format of this edition is entirely new, designed to facilitate revision and extension of the series. The 160 pages are 5½ x 8½ in., printed on one side only, and punched for a standard loose-leaf binder. The special edition, which is available to public libraries only, is supplied with binder and includes service of new specifications as published, and revisions, costs $5. The loose leaf edition costs $3, with $1 extra for binder if desired. Copies can be obtained from the American Public Works Association, 850 East 58th St., Chicago, Ill.

▼

Asphalt Institute Sends Greetings to Montana National Bituminous Conference

PRESIDENT B. L. BOYE of the Asphalt Institute, in a brief address at the opening of the Montana National Bituminous Conference in Glacier Park, September 7, coupled the greetings of the Institute with a hearty invitation to the Annual Asphalt Congress in December. He also struck keynotes in regard to highway programs and tax diversion. Mr. Boye's address follows in full:

"As President of the Asphalt Institute, I bring you the cordial greetings of that organization and the assurance that whatever we can do to further the very useful purposes of this conference, we shall do cheerfully and wholeheartedly.

"Since Colonel Gray, the Chief Engineer of the Institute, and Messrs. Gilmore, Williamson, and Dan Miller, District Engineers, are taking part in this conference, I feel that the technical problems will be in safe hands so far as Institute representation is concerned. Primarily, I am hoping that you who are attending this conference will have your appetites whetted for more, so that you will meet with us at the Annual Asphalt Conference in Memphis during the week of December 6.

"It is a matter of considerable moment that during the calendar years 1934, 1935 and 1936 bituminous highways of all types from surface treatment to hot-mix made up more than 80 per cent of all the state highway construction higher than waterbound macadam. The significance of this showing is that the asphalt highway program has

passed beyond the stage of industry promotion and has become a very fundamental concern of the highway departments themselves, for certainly the highway engineers must secure an abundant fund of information concerning ways and means to make this 80 per cent of their total highway programs most effective.

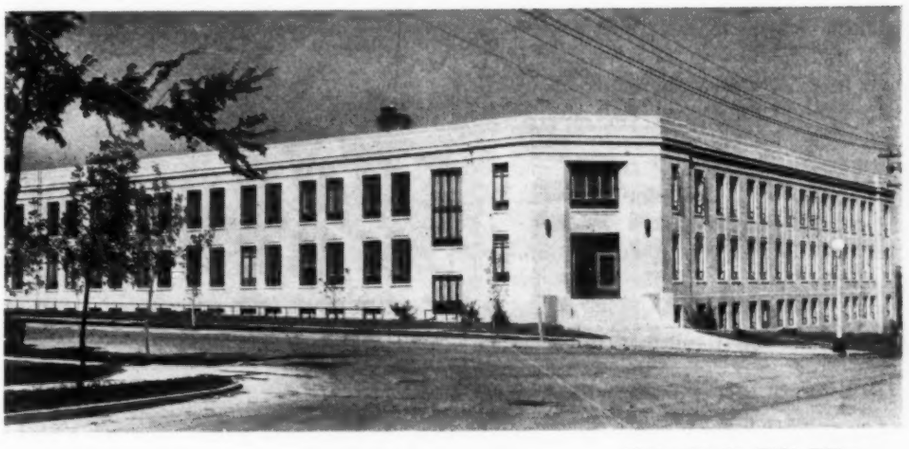
"Meeting with us at Memphis will be the outstanding figures in highway engineering profession in the United States and Canada, and the Association of Asphalt Paving Technologists will meet at the same time and place. We are endeavoring, by the most searching preliminary investigation, to bring the discussions directly to bear upon the problems of the most practical importance to the various states and their highway programs, and we need your full cooperation in accomplishing this desired result. Moreover, the contribution which you will make by reason of your splendid accomplishments throughout this section of the country where you have literally made two dollars worth of highway grow where one grew before will be of untold value to the rest of the country.

"The highway program of the nation is being called upon today to justify itself as never before. Large revenues derived from the gas tax are a constant temptation to the politicians and to the powerful lobbies which seek to divert them to other purposes. A sort of whispering campaign is circulating to the effect that we now have enough highways and that the tempo of highway building should be slowed down. The engineer is very much like the farmer in being distinctly an individualist and an engineering lobby is something practically unheard of. It is therefore exceedingly difficult to combat by an organized counter offense the subtle and continuing raids upon the highway program. The motorist, who in the last analysis pays the bulk of the highway tax, is strangely apathetic in defending his investment in the great national highway system which has made all Americans neighbors. I hope that at every convention and at every organized demonstration, something will be done to resell good roads to the American people so that we may not go backward after having for so many years so brilliantly gone forward. Our highway system will never be completed, and it will never be safe to slow down our rate of progress because more cars, greater speeds, more concentration of population will always necessitate wider, straighter, safer roads, more miles of secondary or farm-to-market roads, rebuilding, resurfacing; and the sooner the American people realize that the conservation of their investment, the safety of their travel and the economical management of the highway program depends upon there being no let-up in highway building, the sooner we shall have attained and assured a stable prosperity."

NO HOUSING SHORTAGES HERE

Highway Departments—North and South—Move into Fine New Homes

MONTANA HIGHWAY DEPARTMENT BUILDING HOUSING GENERAL OFFICES AT HELENA—COMPLETED IN SPRING OF 1937



Photos by the Field Editor

ALABAMA HIGHWAY DEPARTMENT HEADQUARTERS AT MONTGOMERY—NEARING COMPLETION AND PARTLY OCCUPIED JULY, 1937

OBSERVATIONS BY THE WAY

By A. PUDDLE JUMPER

¶ Stickers pasted on my windshield by the time I'd completed the 11,200 mile trip through the Western States. I called on all state highway departments except Idaho, Nevada and Wyoming. At Ports of Entry a "Guest"

sticker is placed on the windshield when the record of the car is taken. Ports of Entry should be handled as in Montana and Texas. The latter are really "Courtesy Stations."

• •

¶ You should see a copy of the General Instructions and Specifications that the Oregon maintenance department had written up for regulation of their many active maintenance crews. It's excellent. I was glad to see the merit system explained and some regulations on "courtesy." Every man now knows where he stands and what is expected of him. The organization is creditably free from politics. Commendation to you, Mr. R. H. Baldock.

• •

¶ Compacting Raylig on an Idaho State Highway Department project east of Shoshone, Idaho. This rubber tired roller compacted the low cost road to a nice smooth driving surface. Raylig is red lignin liquor, a by-product of the manufacture of rayon pulp. It is the natural cement that binds the fibers of wood together in the tree.

• •

¶ The crookedest, twistiest, main highway I believe I've ever traveled is U.S. 101 in Northern California and Southern Oregon. There may be worse ones but I've never traveled them. That beautiful West Coast rugged scenery should be opened to public view by a new highway along the coast line wide enough to permit the tourist to glance westward at the broad, foggy Pacific Ocean, once in a while. Make those big logging trucks help pay for a good highway. They practically regulate traffic movement now.

• •

¶ Summertime in California is watering time for young trees and shrubs along California's highways. The state

highway department has a fleet of tank trucks for watering trees and shrubs as a regular maintenance activity.

• •

¶ I noted with satisfaction that Washington uses reflectorized signs on their main heavily traveled routes.

• •

¶ For warning motorists, about passing where it is unsafe, Washington paints a white traffic line about 3 in. from the standard yellow continuous centerline in the opposite lane from the direction of travel. Other states might well pattern this idea instead of warning by roadside signs. The traffic lines are always visible whereas signs along the shoulder are not so easily seen at night or in a fog.

¶ A scene in a central plant setup of the Western Asphalt Paving Corporation job near Goldfield, Iowa, after a rain of the night before. Mud was hub deep. This is where the profits go. I found the gang whiling away the

time in a little friendly game of "Come Seven." And were they interested? Incidentally I saw a 34-E dual drum paver on this job waiting for the mud to dry up.

• •

¶ If you want to see some beautiful bridges, drive the roads of Oregon. Each bridge is different from another and each artistically designed.

• •

¶ Providing a channel or conduit for damaging waters that scour away a fill protects the new embankment until vegetation can get a good start. The accompanying picture shows how an Ohio county handles this destructive water.

¶ Roadside beauty is a by-product of highway maintenance. It is cheaper to protect and stabilize roadway shoulders than to neglect them. An

accompanying picture shows how one state protects edges of bituminous surfacing and maintain the shoulders and ditches.

• •

¶ North of Salem, Oregon, these two signs take the traveler's eye. Bits

of interesting information like this should be placed by all states on the main roads.

• •

¶ Washington's highway, U.S. 10, through Snoqualmie Pass and for many miles both ways is something of which the state may well be proud. This modern, smooth, concrete highway is designed with easy curves and grades across the Cascade Range. It's the best mountain crossing highway I believe I've ever traveled. Congratulations, Director Murrow, and the contractor, too, for the excellent workmanship.

¶ Another type of traffic lane separation being tested near Pomona, Calif. This is a 4-lane road. The

bituminous mixture piled in the center is about three inches high and four feet wide.

• •

¶ Washington now has a state highway code, modern and inclusive. It was enacted by the 1937 general assembly. State Highway Director,

Lacey V. Murrow (a swell guy) worked on it for 2½ or 3 years before it was accepted.

¶ The accompanying pictures show a clever idea in supporting a trestle span that failed. It is on the bridge over the river along the west edge of

Salem, Oregon, on state route number 22. Note the A-frame trusses carrying loads to adjacent bents and supporting the faulty bent.

• •

¶ Like California, Washington has every type and kind of climate variation and topography. Highway engineers' problems are, therefore, varied and interesting.

• •

¶ I'll let you in on a secret. One of our Western states is considering building a bridge the likes of which there is none in the United States. Watch for my announcement.

• •

¶ This road in Sonoma County, Calif., is protected against slides by a line of perforated corrugated pipe along the toe of the cut. Ground water is intercepted before it can cause a slide.

★ ★ ★ ★ ★
ROAD SHOW and
CONVENTION
Cleveland, Ohio
January 17-21, 1938

ROAD BUILDERS'

OCTOBER, 1937 **AMERICAN ROAD BUILDERS'**

PROGRAM INNOVATIONS

Down the Road

By CHARLES M. UPHAM,
Engineer-Director
American Road Builders' Association, Washington, D. C.

ROADS AND RURAL MAIL SERVICE

The unpretentious mail box on its post by the side of the road symbolizes the romance of letter writing. Ever since frontier days letters have been the wings of American civilization and the voice of its progress. Letters have helped build good citizenship. They have stimulated national good will. They have experienced every method of travel from pony express and stage coach to streamlined train and plane. Ever since the first white settlements were established on the shores of the New World, letters have been dependent on roads to carry them to their destinations.

The roadside mail box is likewise a symbol of the unselfish service of 34,000 rural letter carriers who daily travel, rain or shine, over 1,370,000 miles of the highways and byways of rural America, serving 6,950,000 families and carrying the mail to more than 25,000,000 expectant individuals.

I had the happy privilege of addressing the recent 34th annual convention of the National Rural Letter Carriers Association in New Orleans. The emblem of this splendid organization incorporates the horse and buggy and indicates the necessity of roads to the job of carrying the mail. The emblem does not, however, indicate the willingness of the letter carriers of today to put up with the horse-and-buggy roads of yesterday. Horse-and-buggy roads are things of the past in America and the 15-mile-an-hour highway of a few years ago has been outmoded. The delivery of rural mail today is a mechanized and speedier service. A familiar trail was sufficient to the needs of the pony express rider of pioneer days, but the rural letter carrier today drives a motor vehicle and all-weather roads, therefore, become necessary to the proper delivery of mail in any kind of weather. There can be no excuse for conditions that existed during the past few winters. Rural carriers were compelled in many places to go back to the horse and buggy, to the use of sledges and sometimes had to go on foot to get the mail delivered.

The members of the National Rural Letter Carriers Association are intensely interested in the improvement of the roads on which they spend the best part of their lives. They adopted a resolution at their New Orleans meeting favoring the earmarking of at least 25 per cent of all federal highway money for the construction and maintenance of rural route roads that are not part of existing main or secondary highways. These letter carriers and the rural population they daily serve are looking forward to and should be granted the improvement of farm-to-market roads. While these people know that some scattered improvements have been made in rural road conditions, they realize that rural communities have received fewer good-road benefits than any other subdivision of our population.

News from the political, industrial and educational centers of our civilization is essential to the progress of rural America. The farmer, the cross-roads merchant, the village teacher, the small town preacher, lawyer and doctor, all are vitally concerned with city, state and national legislation; with current questions of national and international importance. The rural community inhabitant has a keen desire to keep in touch with the "outside" world. He has come to depend on the rural free delivery and good roads to bring him the information contained within letters and the pages of his community newspaper to keep him posted on the progress of our great country. Prices, too, are as vital to him as to the broker in Wall Street. The marketability and sales value of his produce determine his future prosperity. Good roads are an absolute necessity to the expansion of daily mail service to the rural communities. Good roads bring encouraging news and a rightful share of the nation's progress to even the most isolated back-country spots.

A.R.B.A. NATIONAL HIGHWAY ADVISORY COUNCIL HOLDS WASHINGTON MEETING

The National Highway Advisory Council of the American Road Builders' Association met in Washington, D. C., Monday and Tuesday, October 4 and 5, 1937, at the Willard hotel. Subjects discussed by members present at this important highway gathering were the federal-aid highway system, the secondary, or farm-to-market system; boulevard highways, regulations pertaining to gas-tax diversion and road-fund appropriations. Round-table discussions were held in connection with the careful consideration of each one of these vital subjects. Invitations had been issued to council members and a highly representative group was in attendance at the two-day council meeting.

REVIEW

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ROAD SHOW and
CONVENTION
Cleveland, Ohio
January 17-21, 1938

ASSOCIATION—WASHINGTON OCTOBER, 1937

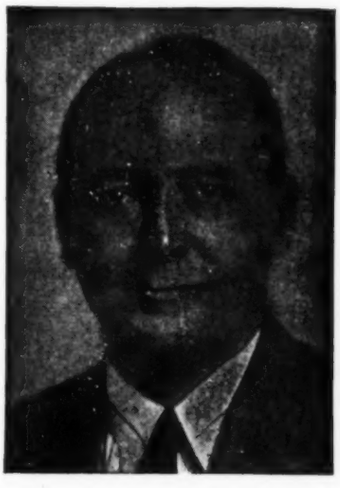
AT 1938 CONVENTION

GEORGIA HIGHWAY CONTRACTORS AFFILIATE WITH A.R.B.A.

The Georgia Highway Contractors' Association, Inc., with offices in the Forsyth Bldg., Atlanta, Ga., is one of the most recent groups of road builders to affiliate with the American Road Builders' Association. The Georgia group has 62 highway-contractor members, all licensed by the state licensing board. Officers of the Georgia Highway Contractors' Association, Inc., four of whose biographical sketches appear on this page, are R. H. Wright, Jr., Columbus, president; Alex MacDougald, Atlanta, vice-president; M. G. Cox, Atlanta, secretary; S. B. Slack, Decatur, treasurer, and Paul L. Andrews, Atlanta, executive secretary. Members of the board of directors are Henry Claussen, Augusta; Carl Espy, Sr., Savannah; Sam E. Finley, Atlanta; D. B. Scott, Decatur; W. C. Shepherd, Atlanta; Dave Wainer, Valdosta; Marvin Woodall, Atlanta, and W. B. Young, Macon.

R. H. Wright, Jr., president of the Georgia Highway Contractors' Association, Inc., attended North Carolina State College at Raleigh and the University of North Carolina at Chapel Hill. He was graduated from the latter institution and soon thereafter made his start in the contracting business. In 1923 he became associated with the Hardaway Contracting Co. of Columbus, Ga. This firm is engaged in bridge building, grading, paving and other construction work.

Paul L. Andrews, executive secretary of the Georgia Highway Contractors' Association, Inc., makes his home in Atlanta. He attended Alabama Polytechnic Institute at Auburn and was later graduated from Princeton. In 1924 Mr. Andrews became acting office and bridge engineer with the Alabama highway department. He later left to become associated with the Truscon Steel Co. as highway representative, covering the states of Alabama, Mississippi and Florida. Mr. Andrews held that position until June, 1937, when he resigned to aid in the organization of the Georgia Highway Contractors' Association, Inc.



R. H. Wright, Jr.

Mose E. Cox, secretary of the Georgia Highway Contractors' Association, Inc., was connected with the Georgia highway department for a number of years, serving in the capacities of consultant and state highway engineer. Since 1935 he has been associated with Sam E. Finley in the contracting business in Atlanta, specializing in bituminous paving.

Searcy B. Slack, treasurer of the Georgia Highway Contractors' Association, Inc., attended the University of Georgia and was graduated from that institution in 1911 and from Harvard the following year. He was for three years a member of the faculty of the engineering department of the University of Georgia. In 1916 Mr. Slack engaged in the contracting business and was also during that time a consultant engineer. In 1917 he entered the army and, after his discharge, again engaged himself as a consultant engineer. Mr. Slack became connected with the Georgia highway department in 1921 and retained the position of bridge engineer until 1923 when he again went into the contracting business and again engaged himself as a consultant engineer. His business is located in Decatur, Ga.

ALL-STAR MUNICIPAL AND COUNTY SESSIONS PLANNED

Expert handling by Frank J. McDevitt, director, Department of Streets and Sewers, St. Louis, Mo., and president of the Municipal Division of the American Road Builders' Association, has culminated in the arrangements of a Municipal Division program for the 1938 "Five-Star" Road Show and Convention to be held at Cleveland, Ohio, January 17-21, 1938, that will take its place as an all-star event. Mr. McDevitt is recognized throughout the nation as one of the leading authorities on city streets and sewerage problems.

John A. Bromley, county roads engineer, Anne Arundel County, Annapolis, Md., and president of the County Highway Officials' Division of the American Road Builders' Association, is known throughout the highway profession as a county engineer whose opinion is accepted as the last word in matters pertaining to county highway questions. He is already promising something entirely out of the ordinary in the way of a program for the convention sessions of the County Highway Officials' Division at Cleveland next January.

Weather and Climatic Cycles

By HALBERT P. GILLETTE

IN ROADS AND STREETS, September, 1928, I first published an electro-magnetic whirl theory of weather and climatic cycles. The theory has undergone some important developments since then. At that time there seemed to be evidence that planets cause sunspot cycles. It is now clear that the converse is true, and that planet periods are nearly harmonic with certain sunspot cycles because the solar magnetic cycles that cause sunspot cycles originally generated the planets. Loss of solar mass has caused the planets to recede from the sun and thus to lengthen their orbital periods. Thus the greatest sunspot cycle is 11.13 years, while the greatest planet, Jupiter, has an orbital period of 11.86 years. It seems probable that when the planets were generated the great sunspot cycle was about 11.5 years, and that Jupiter's orbital period has lengthened about 3 per cent as a result of about 6 per cent loss of solar mass due to the emission of high-speed solar electrons that carried atoms away with them. In this way the approximate harmony of the periods of the planets can be explained. Is it not significant that the orbital periods of Uranus, Neptune and Pluto are almost as 1 : 2 : 3? Their periods are very nearly 84, 164 and 252 years. The period of Uranus is approximately 7 times that of Jupiter and Saturn's period is about 2.5 times that of Jupiter. The Earth's period is about 4 times that of Mercury; and that of Venus is about 2.5 times that of Mercury; and that of Mars about 3 times that of Venus.

In the article above mentioned I suggested a climatic cycle of about 1835 years with a rainfall maximum about 1356 A. D., and another cycle of about 162 years. These two cycles seemed to be shown in tree-ring curves. Later study led me to shorten both of those cycles a little. But recent and more complete analyses have resulted in lengthening the one to 1837 years (with a rain peak in 1380 A. D.) and the other to 167 years. In recent study of this problem, I have used not only the sequoia rings measured independently by Huntington and by Douglass back to 1300 B. C., but Schostakowitch's measurements of the annual silt layers, or varves, in Lake Saki, back to 2300 B. C. These varves confirm the sequoias, and both are confirmed by levels of the Caspian Sea back to the middle of the 5th century A. D.

I find that the 167-year cycle has two important subcycles of 167/35 = 4.77 years, and 167/7 = 23.86 years. There is also a cycle of exactly 2¾ years caused by a gyrating electronosphere whose axis points most directly sunward every 11/14 year and then strongly attracts spiralling electrons from the sun. It combines with the 2¾ year cycle to cause one of 5.5 years which tends to cause confusion as to the weather cycle of 11.13 years due to the sunspot cycle. The 5.5 year cycle had a rain peak March 6, 1930.

The 167-year cycle and its subcycles had a rainfall peak March 6, 1881, when the sun's south pole pointed most directly earthward. A valley of that cycle occurred in 1797 and the next valley will be in 1964. The next valley of the 167/35 and the 167/7 year cycles will coincide and will occur in the fall of 1940, when a repetition of the dry years of 1931 and 1936 may be looked for, probably with greater severity than in either of those years.

The solar electronosphere whose gyratory period is 26.66 days points its axis earthward every 14.36 days, and tends to cause rainfall maxima then. This cycle will have a rain peak Jan. 1, 1938. Last winter four major airplane disasters occurred within a day of a rain peak of the 14.36 day cycle.

There is a rain cycle of 1/5 year or 2.4 months that has a peak March 6. It accounts for "Indian Summer", the "January thaw", and "Ice Saints" (May 11), as well as for the so-called equinoctial storms in March. Those storms have no causal relation to that equinox.

Although the cycle problem is a complex one, it is, I believe, susceptible of complete solution.

There are electron-shells or electronospheres encasing both the earth and the sun. They gyrate in harmony, and their gyrations cause cycles both of sunspots and of weather. Both sun and earth emit electrons, probably because protons are converted into radiant energy under great gravitative pressure. With each conversion of a proton (a positive charge) an electron (a negative charge) is set free. An electron thus set free in a magnetic field rotates around a magnetic axis, thus acquiring magnetic polarity.

If so, the entire cosmos is full of these orientable magnetic units; and at very great distances the magnetic forces of stars exceed their gravitative forces.

▼

To Black-Top 300 Miles of Gravel Per Year

Plans have been announced by Murray D. Van Wagoner, State Highway Commissioner of Michigan, for applying a black-top surface on 300 miles of gravel trunklines a year. Bids already have opened on 16 projects providing for the rebuilding of the gravel base on 122 miles of secondary highways. Incidental grading and drainage construction will also be required.

This work is the first step to be taken by the department for black-topping these roads. The gravel base will be built up to a depth of 6 to 8 in., depending upon soil conditions, in preparation for later surfacing. Oil aggregate surfacing will be applied on these roads next spring and summer.

The 300-mile-a-year program is being financed out of the $5,000,000 annual appropriation for the department enacted by the recent legislature. The funds are to be expended on trunklines that are off the Federal Aid system. By reason of this classification, they have been ineligible for previous improvement the last few years under the cooperative state-Federal programs.

Additional gravel road mileage will also be eliminated by concrete pavements. At the present time, there are approximately 3,100 miles of gravel trunklines in the state.

Economics of Highway Planning Propounded by Oregon Engineers

By VICTOR J. BROWN
Publishing Director, ROADS AND STREETS

PRESSURE by delegations and local political influences bear upon the highway administrator to push the construction of a certain extension or particular improvement. Determination of a priority basis for selection of the extension or improvement on economic grounds would be of material assistance to the engineer or road commission. Recognizing this problem Mr. C. B. McCullough, Assistant State Highway Engineer, State of Oregon, in cooperation with Mr. John Beakey, Traffic Engineer, Oregon State Highway Department, set out to find the answer.

The following presentation is based upon the principles involved as explained by these men in Technical Bulletin No. 7, recently published by the Oregon State Highway Department, entitled, "The Economics of Highway Planning."

In presenting this investigation I shall abstract freely from Bulletin No. 7.

Part I
Fundamentals in Highway Economics

Basic Factors

Every problem involved within the field of highway economics can be directly assigned to the proper correlation of the three essential factor groups: (1) Costs, (2) Revenues, (3) Benefits. The soundness of any development or extension project can be measured by the various ratios of their interrelation.

Revenues must be sufficient to balance *costs,* otherwise eventual bankruptcy is inevitable. A road building body, like any individual, can not purchase expensive items, even though they may be economical over a "period of years," without striking bankruptcy before the "period of years" expires. They must live within their incomes. This tenet is fundamental, the conclusion obvious and inescapable. The criterion set-up is not sufficient within and by itself—it goes only part of the way. Highway revenues must not only be sufficient to meet costs but must, in addition, be warranted and backed up by corresponding *benefits* else the setup will eventually collapse for lack of public support and sanction. In this analysis, benefits are evaluated in such order and detail that revenue imposts may follow benefit distribution in an equitable manner.

Instead of representing the factor groups in the form of capitalized or present value figures, they are discussed in terms of annual values. The annual cost factor will be designated by "C_a" and will include every item of expense involved in the construction, maintenance and operation of the section of highway under consideration. The revenue or income factor is likewise reduced to an annual basis, designated by the term "I_a." The annual benefit factor is "B_a."

The Highway Transport Setup

In evaluating the basic factors it should be borne in mind that the highway transport arrangement differs from the private transport pattern in several details. Rolling stock, for example, in private transport is generally owned by private enterprise and its maintenance and operation constitute a legitimate component of the cost factor, whereas, in highway transport, rolling stock is the property of certain beneficiary groups, and the factor of vehicular operating costs enters the problem from the benefit angle. Highway transport economics therefore, concerns itself with the cost of vehicular operation only because of the savings effected in this item by virtue of road improvements.

Another difference in the two setups is that, in private transport, revenues are generally obtained directly from the customers or shippers in the form of traffic tariffs, whereas, in highway transport, gross revenues are obtained from various sources, among which are the following:

(1) From the federal government in the form of direct grants. These grants are, presumably, a consideration, in part, for highway facilities furnished by the states for the transportation of the mails, and in part, an equitable distribution of road user imposts. They may also be considered, in part, as a special subsidy to interstate commerce. Federal grants for roads through national public lands are presumably made in lieu of the collection of property taxes.

(2) From motor vehicle fees, motor fuel taxes and similar imposts on the road user, levied, in general by the state, and being presumably a direct charge on the patrons of the system in relative degree to the transportation benefits derived therefrom.

(3) From general property taxes levied by states, counties and other political subdivisions for road purposes. These levies are presumably in consideration for those many general benefits independent of motor vehicle ownership. These benefits eventually and inevitably flow to the community at large by virtue of facilitated motor transport.

(4) From special assessments levied against abutting and adjacent property for city pavements, and for special rural road districts. They are presumably levied in consideration for individual and particular benefits accruing to abutting or adjacent property in addition to and entirely separate from either general community benefits or road user transportation benefits.

(5) From special government grants in the form of relief funds. These are purely emergency measures of benefit to employment and their benefits are incidental to the highway setup. They have no logical place in economic revenue sources in a transportation analysis.

A third difference in setup occurs in the enumeration of benefits. Beneficiaries of the highway system may be grouped as follows:

(1) *The federal government* because of improved facilities for transportation of the mails, of facilitated access to national parks, forests and reserves, of facilities provided for interstate commerce, and of other factors.

(2) *The road user* because of decreased vehicular operating costs, of increased riding comfort and safety, and of other factors.

(3) *The general public* embraced within the state, county or other political subdivision because of decreased commodity costs, of promotion of public health, of better police facilities, of improved fire protection, and of such other distinctly existent benefits which may be classed under public welfare. These

accrue to the community as a whole regardless of motor vehicle ownership.

(4) *Abutting and/ or adjacent property* because of certain special benefits accruing thereto over and above general community benefits. Improved sanitation by dust elimination, improved convenience by mud elimination, surety of all-weather travel and similar features are independent of road use.

Problems in Highway Administration

The principal problems of the administrator are:

(1) The selection and designation of highway routes and development projects and the determination of a priority basis for their improvement.

(2) The apportionment of that prorata of cost for any highway or street or class of highways or streets which should in equity be carried by each of the beneficiaries thereof. In other words, the portion of cost that should be borne by the highway user, by a general tax, or by special assessment on abutting or adjacent property.

(3) As a corrollary to the above, the determination of that prorata of funds from each of the sources of revenue, which should in equity and reason, be allocated to each of the various classes of roads and streets.

(4) The determination of the internal distribution of that portion of the total cost burden carried by motor transport among the various kinds and classes of vehicles involved.

(5) The economic location and design of new construction and reconstruction.

These are the principal problems of the administrator, and each may be reduced to terms involving the interrelation of the three elemental factor groups named. They dovetail in a study of the economic development of a highway improvement and extension plan.

The balance of this article is taken directly from Chapter II of Technical Bulletin No. 7, Oregon State Highway Department. The bulletin goes on to develop each of the terms involved and gives supporting data for all statements and calculations. For example, Chapter III is devoted to an analysis of the Cost Factor group, in which C_s (total annual cost) is broken down into its components C_{sc} (annual construction cost), C_{sm} (annual maintenance cost), and C_{so} (annual operating cost). The material is of book length and therefore impractical of presentation here. This article, however, outlines the general method of attack and for that reason justifies its presence.

Part II

The Solvency Factor

The Solvency Quotient

The first steps are obviously the evaluation of the annual cost factor (C_s), the annual road user revenue or income factor (I_{sr})*, and the various annual benefit factors (B_s).

The various factors entering into each of these basic factor groups will be developed later in this analysis, together with methods whereby they may be evaluated with a reasonable degree of accuracy and equity. In order to proceed to the conclusion of our preliminary outline, however, let us consider, for the moment, that this evaluation has been made for the particular highway or group of highways under consideration. If these fall within a group wherein it has been determined that road user funds are to be used to defray the entire expense, it is apparent that the ratio I_{sr}/C_s is an index of the economic solvency of the project. If this ratio is less than unity, the *project can not* be financed unless there exists *a surplus of road user revenues* from other branches of the system to make up the deficit.*

It is, however, neither desirable nor equitable that road user earnings be burdened with the *entire cost* of all of the highway systems of the state since there are other beneficiaries, as previously set forth, which in all equity, should be called upon to bear a portion of this expense; nor is it possible to balance annual costs and road user incomes to such a degree of nicety that the prorata I_{sr}/C_s will remain constant for the highways in any particular group. It is possible, however, by dividing highways into certain broad basic groupings, to determine for each group or major classification the approximate prorata of cost which should, in equity, constitute a charge against the road user and the manner in which the residuum should be prorated among the various remaining beneficiaries. This is obviously another problem entirely. The present problem is clearly one of selection for which reason let it suffice to assume that the prorata cost chargeable to road user funds has already been determined and that the constant K_1 represents such equitable percentage allocation.

Clearly then, the ratio I_{sr}/K_1C_s represents the index of solvency for the project under consideration. Hereinafter this will be known as the "solvency quotient" and designated by the term "Q_s". It is obvious that if Q_s equals unity, the project is *solvent*, but not *surplus producing*. If Q_s is greater than unity, a surplus for further highway extensions or improvements will be created. If Q_s is less than unity, the project can not be justified on economic grounds alone, and in fact is not feasible unless there exists from other highways of the system a revenue balance which is available for reappropriation to make up the deficit.

At first glance the impression might be gained that the development of this so-called solvency quotient (Q_s) is simply another way of stating that the heavier traffic roads should be first on the list for improvement. This, however, is not strictly true although the solvency quotient trend will generally be in the direction of traffic. In the first place, the gross earnings for any section of highway are not a linear function of traffic but depend upon the kind and character of traffic as well as its volume. In the second place, the solvency quotient must be determined not from present traffic conditions but from the *average annual earning expectancy* during the service life of the improvement contemplated. The income factor (I_{sr}) must therefore be determined from traffic trends both as regards volume and character. It is entirely conceivable that, of two roads under consideration, the one which carries the heaviest traffic today may clearly indicate the less promising revenue possibilities over a period of years. It should also be noted that the solvency quotient (Q_s) carries the annual cost factor as denominator so that even though the survey for a certain highway indicates a gross traffic revenue in excess of another competing route, its annual cost may be sufficiently large to reverse the order of the income-cost ratios.

*The total annual income I_s obviously comprehends all revenues accruing to the project regardless of source. For the purpose of this analysis, however, we are concerned only with road user revenues which will hereinafter be designated by the term I_{sr}.

*It should be mentioned here, however, that in the usual highway sytem a small percentage of the mileage produces by far the bulk of the road user revenue, and, in fact, provides a subsidy for the development of the balance of the system. It is obviously unsound to return to the heavy revenue producing roads the entire amount they produce, and it is equally unsound to attempt to reduce revenues to the point where the relationship I_s/C_s is no more than balanced for any road in the system. In the first instance we would have a development of certain roads far beyond the actual need, and in the second we would stifle development of the system.

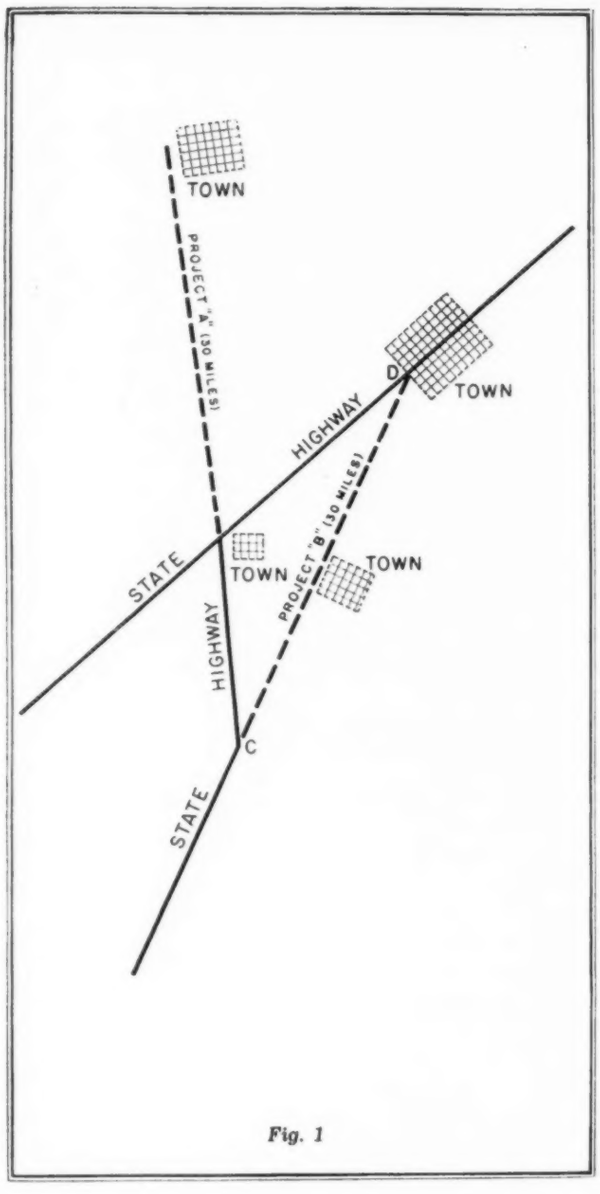


Fig. 1

From the above, therefore, it is apparent that the true measure of *financial* desirability is the solvency quotient (Q_s) rather than the type or volume of traffic carried.

Limitations of Use of the Solvency Quotient

In developing the solvency quotient for any road or group of roads, it should always be borne in mind that the traffic earnings considered must be those which are developed on the road by and within itself *without draining* traffic from any other route on the system.

Perhaps this point deserves elaboration. As an illustration, let us consider the question of choice between the two routes designated as "Project A" and "Project B" in Fig. 1, both of these routes being candidates for addition to a certain highway system, let us say, for example, the secondary highway system of the state. Neither of the routes are improved at present, and neither route is receiving aid from road user funds. Project "A" has a present earning capacity of I_{sr} dollars per annum, and while this is not sufficient to warrant its improvement, an investigation of future traffic trends indicates a favorable solvency quotient (Q_s) based on estimated average annual revenues during the service life of the improvement contemplated. Let it be assumed that the secondary highway system is solvent within itself. In other words, that the road user revenues derived solely from and within the present secondary highway system are sufficient to meet its legally established prorata of annual cost. Such an assumption is reasonable since otherwise no extensions should be under consideration. Based on this assumption, it is apparent that Project "A" is producing a surplus road user revenue at the present time in the amount of I_{sr} dollars per annum. It is obvious that the improvement of this project would operate to deplete this surplus. Such a result is inevitable. The general solvency of the secondary system, however, will not be in any degree affected. The solvency quotient indicates that Project "A" is eligible for improvement, and its estimated future earnings are simply being reallocated back to it out of surplus funds. Perhaps without improvement, traffic would never have been sufficient to develop a favorable solvency quotient. The very improvement itself will create traffic and augment road user revenues. In any event, Project "A" is standing on its own feet, as it were, and its improvement has no effect on the general solvency of the secondary system as a whole.

In contrast to Project "A" let us consider the route designated as Project "B". This route, as indicated in Fig. 1, is of exactly the same length. Let us assume, in order to fully illustrate the point involved, that its future estimated earnings (I_{sr} dollars) and its annual cost for improvement (C_s dollars) are exactly the same as for Project "A". The derivation of the solvency quotients will therefore indicate no choice or preference between the two projects. A further investigation, however, discloses the fact that unlike Project "A", Project "B" will derive 50 per cent of its traffic revenue by draining traffic from existing state highway routes because of the fact that it acts as a cut-off between points "C" and "D" (Fig. 1). Such a traffic drainage does affect the solvency of the existing system. In computing the earning capacity (I_{sr}) of Project "B", therefore, it becomes necessary to segregate the traffic and to deduct that portion of the traffic earnings which arise by virtue of the function of this project as a cut-off; in other words, as hereinabove stated, to consider, in deriving the solvency quotient, only that portion of the total traffic earnings which are developed on the road by and within itself without draining traffic from any other route on the system.

In summary, therefore, the financial soundness or economic expediency of selecting any new road or route for addition to an existing highway system can be measured by the solvency quotient, provided that no portion of the road earnings utilized in the derivation of this quotient value are from traffic drained from any portion of this or other existing highway systems financed in whole or in part from the same source.

Investigation of Total or System Solvencies

It will be observed that the intelligent and proper application of the solvency quotient method, hereinabove outlined, pre-supposes a knowledge concerning the solvency of the present existing system as well as that for the particular project proposed for addition. If the present existing system is not solvent within itself, it obviously must be deriving support from feeder roads

outside of its own limits. In such a case, the earnings derived from these outside or feeder roads are needed in whole or in part to make up this deficit, and therefore can not properly be used for extensions. On the other hand, a condition may obtain wherein the existing system is producing surplus revenues within itself. In this latter case, a meritorious extension project may be economically possible even though the project itself will not produce sufficient revenues to develop a favorable solvency quotient. In other words, existing road systems may produce surplus revenues within themselves which may be made available for aiding meritorious extension projects not able to stand entirely on their own feet.

It is therefore necessary in formulating a sound policy of highway extension, to effect an accurate determination of the solvency of each existing highway system, and to keep a record, accurate and up to date, indicating the surplus or deficit produced on each highway or section of highway composing the system.

The Benefit Factor

The foregoing discussion has confined itself to a definition and derivation of the solvency quotient (Q_s) and to the method of its application. Such a quotient, however, fails to furnish the sole criterion for the selection of the components of a highway extension program. That this is true may be readily appreciated from a consideration of the setup indicated in Fig. 2. Let us assume that, in the locality indicated in this figure, it is desired to select one additional road for placement on the state secondary system, and that the choice has narrowed down to the two routes indicated as "Project C" and "Project D". Let it also be assumed that both a physical survey and a traffic survey have been completed and designs and estimates of cost prepared and that as a result of these investigations, the following data have been derived.

Project "C":

Annual cost (C_s)	$12,000
Present annual income	3,000
Estimated average annual income during service life, if improved (I_{sr})	7,000

In accordance with the deductions and conclusions hereinabove drawn, this future income is based upon the traffic derived exclusively from Project "C" itself and does not include any portion of the income from traffic which will be diverted to Project "C" from adjacent state highways.

Project "D":

Annual cost (C_s)	$10,000
Present annual income	2,000
Estimated average annual income during service life, if improved (I_{sr})	8,000

Without, at this time, going into the matter of allocation of funds, let it be further assumed that such an allocation has been previously determined and established and that 60 per cent of total road improvement costs for the secondary system are to be defrayed from motor vehicle funds, and 40 per cent from funds derived from other sources.

Applying the solvency quotient method to the two projects under consideration, we have:

$$\textit{For Project "C":}\quad Q_s = \frac{\$7{,}000}{60\% \text{ of } \$12{,}000} = \frac{70}{72} = 0.97$$

$$\textit{For Project "D":}\quad Q_s = \frac{\$8{,}000}{60\% \text{ of } \$12{,}000} = \frac{8}{6} = 1.33$$

From the criterion of solvency quotients alone, Project "D" shows up quite favorably in the comparison and should therefore be selected. Looking further into the problem, however, it is seen that Project "C" performs a dual function. It acts not only as a feeder road but also as a state highway cut-off. In its cut-off function it operates to effect a large saving to traffic operating over the state highway routes in the direction indicated by the arrows in Fig. 2. This factor obviously has been disregarded entirely in the above analysis. As a matter of fact, if it had been taken into consideration from the standpoint of road revenues only, the result would have been a *further decrease* in the solvency quotient for Project "C" for the reason that, if traffic conditions remain constant, the *very fact of shortening* state highway travel by virtue of any *cut-off* operates to *decrease* existing earning capacities.

In summary, therefore, it is apparent that the solvency quotient alone does not meet this situation. Judged

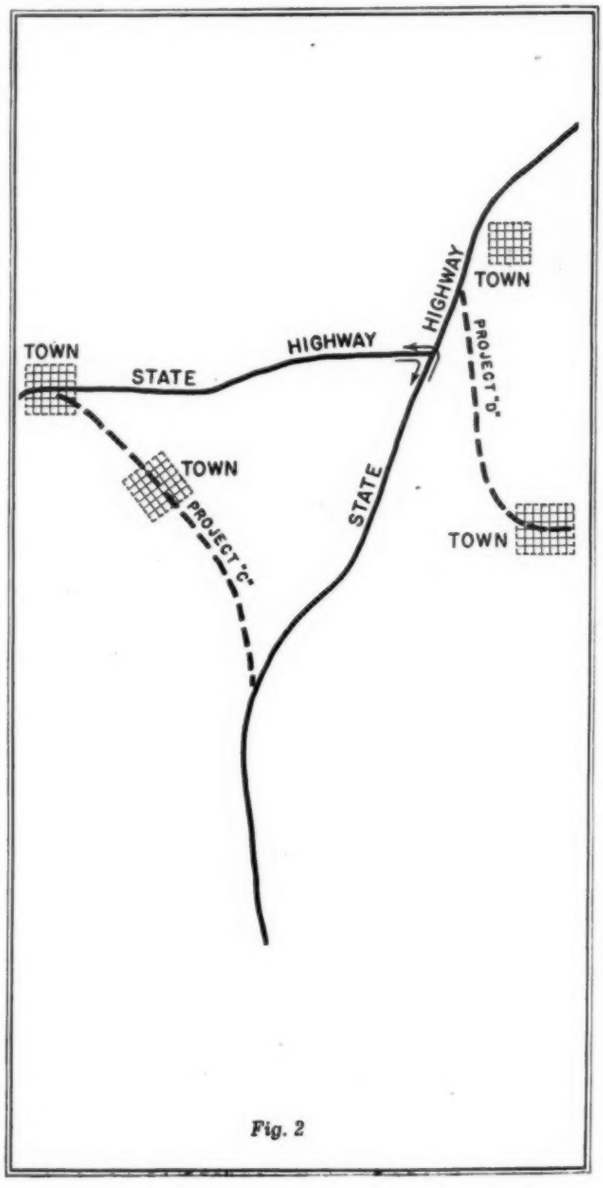


Fig. 2

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solely by this criterion, cut-offs and line revisions could never find economic justification. Another factor enters into the problem. This is clearly the factor of road user benefits. It is the purpose of the discussion which follows, to develop a method for evaluating these benefits and a second criterion quotient which hereinafter will be designated by the term Q_B.

Road User Benefits

Before attempting to develop a numerical evaluation of the benefit quotient Q_B it becomes necessary to enumerate carefully the various benefits involved. These may be outlined according to broad basic classifications, as follows:

Total Benefits:

1. Direct road user benefits.
   - a. Mileage element benefits.
     - (1) Fuel functions.
     - (2) Non-fuel functions.
   - b. Time element benefits (non-fuel functions).
2. General benefits.
   - a. Commonwealth or national benefits.
   - b. Community benefits.
   - c. Land service or special property benefits.

The above classification is merely into basic groupings. The breakdown obviously must be more detailed and complete to effect a final analysis, but for the present it will suffice since our primary interest is still focused upon the development of a general method of attack.

The scope of the present inquiry embraces but one problem—the selection of highway mileage. It does not extend to the question of an equitable apportionment of roads costs among road beneficiaries but seeks only to derive a method of measuring the relative desirability of different mileage extension or improvement projects from the standpoint of the road user and road user revenues. The present inquiry, therefore, is only interested in road user benefits.

The breakdown outline hereinabove given yields two final classifications for road user benefits, the first being a function of automotive fuel costs while the second is independent thereof. That such a segregation is necessary to a proper analysis will be developed subsequently.

Fuel function benefits are clearly derived from a comparison of vehicular fuel consumption over the proposed project or route, as against similar data for present existing facilities between the same termini. If the proposed project is a new location, fuel consumption value should be compared with those over all existing routes between the same termini whose traffic will be diverted, in whole or in part, to the new line, and the amount of traffic which will be diverted to such a new line from each existing route, must be estimated. If the proposed project is simply an improvement of an existing location, with no possibility of traffic drainage from other existing highways, fuel consumption comparisons should be made against the present road. It was pointed out in the section on solvency quotients that traffic drained from existing routes already on the system must be disregarded in computing revenues. This was true for the derivation of the solvency quotient since our concern was at that time with revenues. Now we are considering road user *benefits*, not revenues. These benefits exist independently of traffic locale. However, we must *know* where traffic comes from in order to effect a fuel consumption comparison.

Fuel function benefits are principally derived from:

(a) A reduction in distance between termini.
(b) An improvement in roadway surface.
(c) A reduction in rise and fall.
(d) An improvement in gradients.
(e) An improved alignment (reduced curvature, increased sight distance, etc.)
(f) Elimination of traffic stops.

Non-fuel function benefits include savings in lubricants, tires and tubes, vehicular maintenance and a certain prorata of vehicular depreciation. They also include time savings for drivers and passengers, and augmented traffic safety conditions.* Non-fuel function benefits in the "mileage element" group are, in general, derived from the same factors as above listed for the fuel function class. The "time element" benefits are also derived from these factors and from the following additional conditions:

(a) Increased roadway and shoulder widths.
(b) Elimination of intersections and railroad grade crossings.
(c) Other miscellaneous minor factors to be discussed later.

The evaluation of the above factors is a tedious and involved procedure, and its ramifications many and long. This phase of the analysis will be considered in detail in a subsequent chapter. Let us, for the moment, assume that all such data have been secured and assembled so that we can proceed forthwith to the development of this portion of our outline exactly as was done in the case of the derivation of the solvency quotient Q_s.

The Benefit Quotient

Let it be assumed that for the particular project under consideration, the various fuel function benefits have been determined and let their aggregate annual value be represented by B_f. Likewise, let B_n represent the annual value of the total non-fuel function benefits to the road user. As in the case of the discussion of solvency ratios, let C_s represent the annual cost of the project under consideration and K_1C_s represent that portion of the annual cost to be defrayed from road user funds.

Then Q_B, the total benefit quotient, is determined by the expression

$$Q_B = \frac{B_f + B_n}{K_1 C_s} \qquad (1)$$

This total quotient is obviously the sum of the two partial quotients Q_{Bf} and Q_{Bn} where

$$Q_{Bf} = \frac{B_f}{K_1 C_s} \qquad (2)$$

$$Q_{Bn} = \frac{B_n}{K_1 C_s} \qquad (3)$$

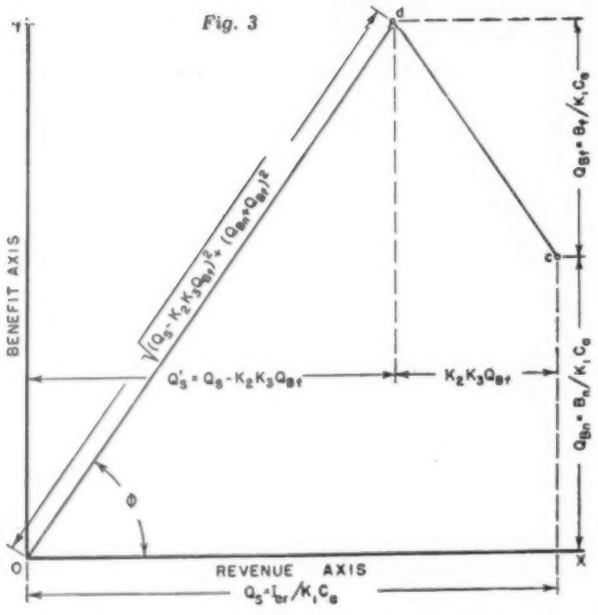
Combination of Factor Groups

General Discussion

The quotients last above derived are clearly a measure of the desirability of the project from the standpoint of road user *benefits* and the question which next presents itself is this: How may these quotients be combined with the solvency quotient Q_s in order to arrive at a composite

*The elimination of accidents that are attributable to a condition of the road results in a considerable saving not only directly to the road user but also may be considered as a general benefit. This matter is discussed more fully in Chapter VI of the Economics of Highway Planning.

Fig. 3



value which will in a sense measure the total ratio of interrelation between the three basic factor groups *costs*, *revenues* and *benefits?*

Clearly they can not be added directly as scalar values. One can not add horses and cows and arrive at a result in composite units. The answer will still be horses and cows. Neither does their multiplication yield a result that has much logic to defend it. The composite result of such a manipulation would be represented by the expression

$$Q_B\,Q_s = \frac{I_{sf}}{K_1^2} \qquad \left\{\frac{B_f + B_n}{(C_e)^2}\right\}$$

which has little significance. It is apparent that we must look further.

If the component quotients are combined by a process of *vector* or geometric addition, the result has a certain degree of logical significance. Consider, therefore, the coordinate diagram indicated in figure 3 in which the revenue vectors are plotted positive to the right along the axis OX, and the benefit vectors positive upwardly along the axis OY.

The solvency quotient is entirely unrelated to road user benefits and therefore has no component in the direction OY. The component benefit quotient Q_{Bn}, on the other hand, is entirely independent of road user revenues, and may therefore be plotted in the direction OY. By laying off to any convenient scale the value Q_s along the axis OX, and from its outer terminus erecting a perpendicular whose scalar value is Q_{Bn}, the point "c" is located. The factor Q_{Bf} remains to be added geometrically.

It has been shown that the partial benefit quotient Q_{Bn} is entirely unrelated to road user revenues. This is not true of the partial *benefit* quotient Q_{Bf}. The virtue of a saving in motor vehicle fuel, and for every dollar thus saved, road user revenues are correspondingly depleted. For the traffic which is developed on the road in question *by* and *within* itself this depletion in road user revenues has already been taken into consideration in determining the solvency quotient Q_s. In certain instances, however, particularly in the case of relocations and cut-offs, a certain portion of the traffic on the new project will be drained from existing highways, and while it is true that the revenue from this traffic has not been taken into consideration in computing the solvency quotient Q_s, yet nevertheless the very fact that this traffic drainage is accompanied by a corresponding decrease in motor vehicle fuel consumption operates to deplete the system funds by a certain corresponding amount. In other words, notwithstanding the fact that traffic drained from existing highways is not considered in developing a solvency quotient, any saving in motor vehicle fuel accruing to this traffic is accompanied by a corresponding reduction in the total motor vehicle revenue on the system derived from fuel tax, for which reason *the solvency of the existing system is affected.*

In those cases, therefore, wherein a portion of the traffic on the project in question is to be derived from existing highway routes by virtue of distance savings or other similar factors, the benefit factor Q_{Bf} will carry along with it a corresponding reduction in revenue ratio. If K_2 represents the proportion of the total fuel savings which is derived from the traffic drained away from existing highway routes, and, if K_3 represents the ratio of fuel tax to total cost of fuel, the value of this revenue deduction component is given by the expression $K_2K_3Q_{Bf}$ which value is therefore laid off parallel to the OX axis, but in a negative direction from point "c" to locate the final terminal point "d" (see Fig. 3).

Derivation of Composite Quotients

It should now be clear that the composite effect of all of these operative factors expressed in ratio form, may be represented both in scale and direction by the resultant line Od.

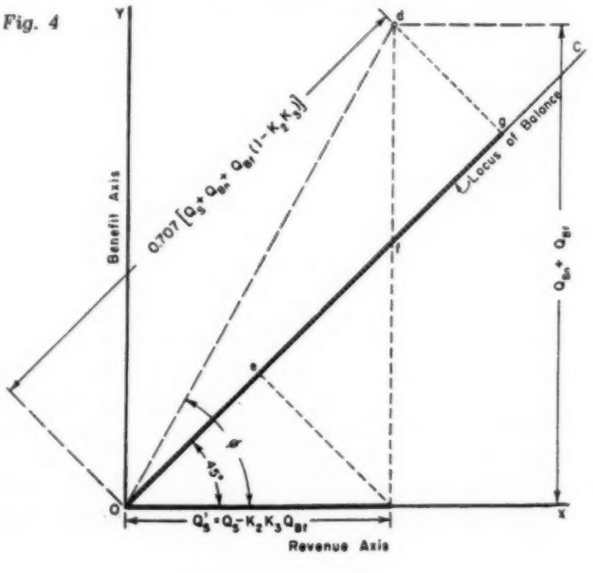
The point "d" may be located directly, if desired, by means of the following equations (see Fig. 3).

$$Od = \sqrt{(Q_s - K_2K_3Q_{Bf})^2 + (Q_{Bn} + Q_{Bf})^2} \qquad (4)$$

$$\phi = \arctan \frac{Q_{Bn} + Q_{Bf}}{Q_s - K_2K_3Q_{Bf}} \qquad (5)$$

In a sense, this last expression (given in equation 4) represents the composite quotient value which we are attempting to derive, and could doubtless be used as such since, after all, what we are seeking is simply a standardized method of combining benefit and revenue factors for use as a basis for comparing highway extension and improvement projects. Equation 4, however, can be simplified and its use rendered somewhat more significant

Fig. 4



and logical by means of the following transformation.

Let us consider (see Fig. 4) a condition wherein the terminal point "d" in the vector addition of revenue and benefit quotients has already been located. This obviously can be accomplished by means of equations 4 and 5 above. If, now, a third coordinate axis (OC) be constructed through the origin and at 45 degrees with the revenue and benefit axes, it is apparent that such axis will constitute the locus of all points which define an equality of benefits and revenues. This third axis may be termed the "locus of balance."

If the terminal point in any vector addition of revenue and benefit quotients falls on the axis OC, the condition defined is one wherein road user benefits just balance motor vehicle revenues. In other words, the road user, in this case, derives benefits exactly commensurate with the taxes he pays.* There is no particular advantage to him, therefore, in having the road improved as his savings in fuel, lubricants, tires, etc., coupled with his savings simply accumulate a sufficient amount to pay his motor vehicle and fuel taxes, and no more. If the terminal point "D" falls above the locus of balance, the benefits derived exceed the imposts levied, and the intercept "fg" obtained by dropping respective perpendiculars from point "d" upon the revenue axis and the balance locus constitutes an index of the excess benefits thus derived.

If, on the other hand, the terminal point "de" falls at some point (such as "d_1" in Fig. 5) below the balance locus, a deficiency in road user benefits is indicated. Under such conditions there would appear to be insufficient justification for the road improvement contemplated. The road user's tax would exceed the benefits accruing to him. It would be to his advantage in this case, to utilize present existing facilities.

From the foregoing analysis, it appears, therefore, that the construction of this "locus of balance" constitutes a simple method for graphically indicating the relationship between benefit and revenue quotients and that the angles ($\varnothing$) and intercepts (fg) constitute quantitative indices of such inter-relation.*

As hereinabove stated, the scalar value of Od (determined by equation 4) may be used for the composite quotient value; however, if the vector Od be projected upon the locus of balance, the resultant value Og constitutes a somewhat more logical index. From figure 4 it will be seen that this value Og is given by the expression

$$Og = 0.707\,[Q_s + Q_{Bn} + Q_{Bf}\,(1 - K_2K_3)\,] \qquad (6)$$

This last expression, therefore, represents as nearly as is possible mathematically, the composite desirability of the project under analysis when each of the three basic factors (costs, revenues and benefits) is given due and proper consideration.

The *solvency component* of the vector Od is given by the expression

$$Q'_s = Q_s - K_2K_3Q_{Bf} \qquad (7)$$

This represents the net ratio of road user income to road costs for the project under analysis when due and proper consideration is given to the general depletion of road revenues arising by virtue of any decreased fuel consumption by traffic drained from existing highways on the system.

Figure 6 indicates a type of data sheet which can conveniently be employed for plotting the terminal points in the vector addition of revenue and benefit quotients for competing improvement or extension projects, and for studying graphically the benefit-revenue inter-relation. The terminal points are readily plotted from the data given in equations 4 and 5, and the resulting radius vectors projected upon the locus of balance furnish a graphical method for comparing composite quotient values. To illustrate the application of this method, consider the five projects indicated in Fig. 6.

The terminal point for Project No. 1 lies below the balance locus and can be eliminated at the outset. In other words, there is clearly *insufficient* justification for this improvement on the grounds of transportation benefits. Project No. 2 has a favorable benefit-revenue ratio but a

*This is not true unless motor vehicle imposts are used exclusively for highway purposes. It is substantially true when the only diversion is a small deduction for collection and administrative expense.

*When the terminal point "d" falls on the benefit axis (that is to say when $\varnothing = 90°$) a condition obtains wherein no additional revenues are created by the improvement. Such a condition is represented in the construction of a bridge structure or some similar improvement internal to any section of highway which in no way affects its earning capacity.

When the terminal point "d" falls in the second quadrant (i. e., when $\varnothing$ is greater than 90°) a condition obtains wherein existing road revenues are actually depleted by the improvement in question. Such a condition is represented by local cut-offs and line revisions which decrease fuel consumption over the line with no corresponding traffic increase.

Fig. 5

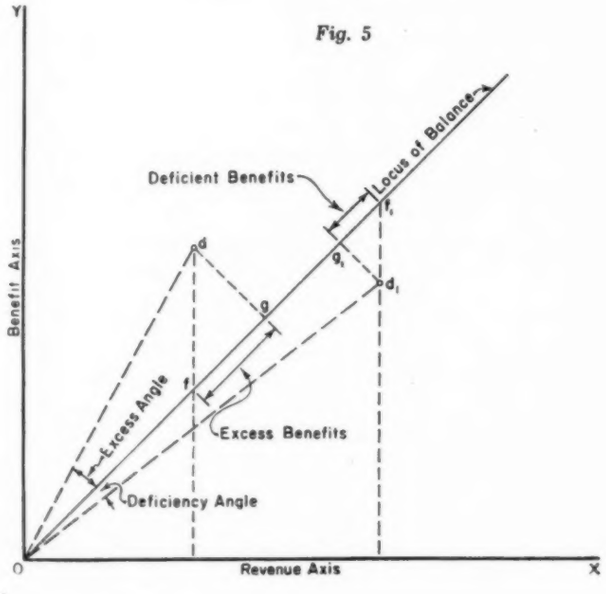
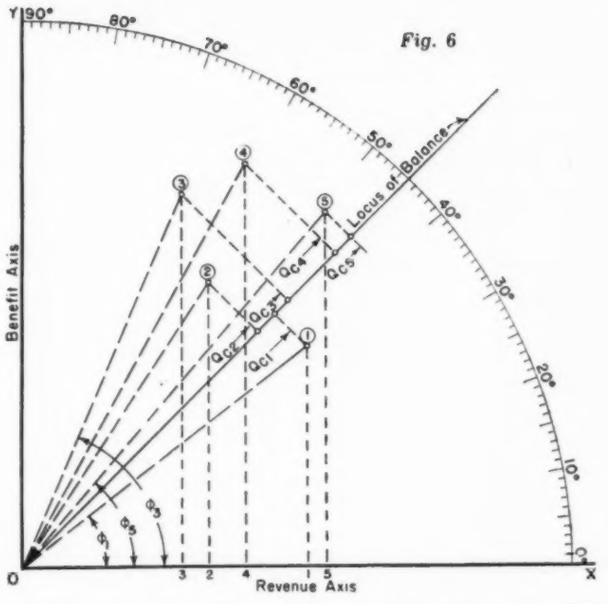


Fig. 6



low *composite quotient* value. This project, therefore, may also be eliminated. The large value of the angle $\varnothing$ for Project No. 3 indicates ample justification for its construction; however, its earning capacity is very low. The choice, therefore, appears to narrow down to Projects Nos. 4 and 5, the former having greater justification while the latter indicates the more promising revenue possibilities. The composite quotient value for Project No. 5 is slightly higher, and all things considered, this project is therefore the most desirable.

In conclusion, it should again be emphasized that the selection of highway improvements is not a problem susceptible of *exact mathematical solution*. After all is said and done, the final selection must be, to a certain extent, tempered by judgment and a knowledge of individual conditions and needs. The most that can be expected from the above is the development of a somewhat crude measuring stick and a method which will indicate graphically the interrelation of the factors involved.

Summary of Procedure

The foregoing analysis is far from rigorous, but it approaches mathematical accuracy as near as is possible considering the variants of the problem. It furnishes a measuring stick all too crude, it is true, but nevertheless one of the few methods yet suggested which has any logic or mathematical significance to defend it.

In brief summary, the method may be restated as follows:

(1) The financial soundness or economic expediency of selecting any new addition or improvement to an existing highway system can be measured by the solvency quotient

$$Q_s = \frac{I_{sr}}{K_1 C_s} \qquad (8)$$

where I_{sr} = the estimated average annual income from road user taxes accruing to the project during its service life.

C_s = The average annual cost of the project inclusive of every item of expense involved in its construction, maintenance and operation.

K_1 = That prorata of total annual cost which is to be defrayed from road user earnings.

If any portion of the estimated road earnings are derived from traffic drained from any part of an existing highway system financed in whole or in part from road user funds, such portion of the earnings shall not be considered in computing "I_{sr}".

Furthermore, the solvency quotient "Q_s" in this latter case shall be corrected by deducting the value $K_2K_3Q_{Bf}$ so that the revised solvency quotient shall be expressed as follows:

$$Q'_s = Q_s - K_2K_3Q_{Bf} \qquad (9)$$

where

Q'_s = the revised or corrected solvency quotient.

Q_s = the original solvency quotient.

K_2 = the ratio of the fuel savings on all traffic drained from any existing highway system or systems to the total fuel savings.

K_3 = the ratio of motor fuel tax to total fuel cost.

Q_{Bf} = the ratio B_f/K_3C_s where

B_f = the benefits accruing to traffic on the project which are "fuel functions". In other words the total cost of fuel savings on the project under analysis.

(2) The composite desirability or order of preference for any project when *road user benefits* as well as highway *incomes* are considered may be expressed numerically by the composite quotient Q_c which is determined by the expression

$$Q_c = 0.707\ [Q_s + Q_{Bn} + Q_{Bf}\ (1 - K_2K_3)\ ] \qquad (10)$$

where Q_{Bn} = the ratio B_n/K_3C_s, and where B_n represents the benefits accruing to traffic on the project which are "non-fuel functions"; that is to say, benefits other than fuel savings.

All other items in the above formula are as previously defined.

As before stated, the solvency quotient "Q_s" (or Q'_s) is a measure of the *financial expediency* of the project. There is a solvency quotient limit below which it is inexpedient and sometimes impossible to go regardless of the road user benefits derived without raising taxes. If the improvement selections are kept within these limits their *composite* quotient values come as near as is possible, with the more or less indefinite nature of the factors involved, to measuring their general desirability or order of preference.

Outline of Detailed Method of Analysis

The foregoing articles have concerned themselves with the development of a general theory and the derivation of co-efficients or quotients which can be used to a certain extent as measuring sticks for testing the financial soundness and also the general desirability of additions and improvements to existing highway systems regardless of whether they be in the nature of cut-offs, relocations or new routes. It now remains to outline the detailed procedure by means of which these co-efficients may be developed. The necessary steps are outlined hereinbelow and each step will be treated in detail in succeeding chapters.

1. *The determination of the average annual cost factor "C_s".*

This factor, as previously stated, must include every item of expense involved in the construction, maintenance and operation of the project under consideration. In general, it will include the following items:

a. Capital costs.
b. Maintenance costs.
c. Operation costs.

2. *The determination of the average annual road user revenue factor "I_{sr}".*

This portion of the study necessitates a survey of present traffic and also a determination of future traffic trends. It involves the determination of traffic patterns, the segregation of traffic into different groups according to earning capacity and the determination of the average revenue expectancy from each class or group.

3. *The determination of the benefit factors B_f and B_n.*

The factor B_f, as previously stated, is simply the value of fuel savings accruing to traffic from the improvement of the project under analysis, while the factor B_n includes all of the accruing road user benefits which are not fuel functions, such as savings in lubricants, tires and tubes, vehicular maintenance and depreciation, time savings, augmented traffic safety conditions, etc.

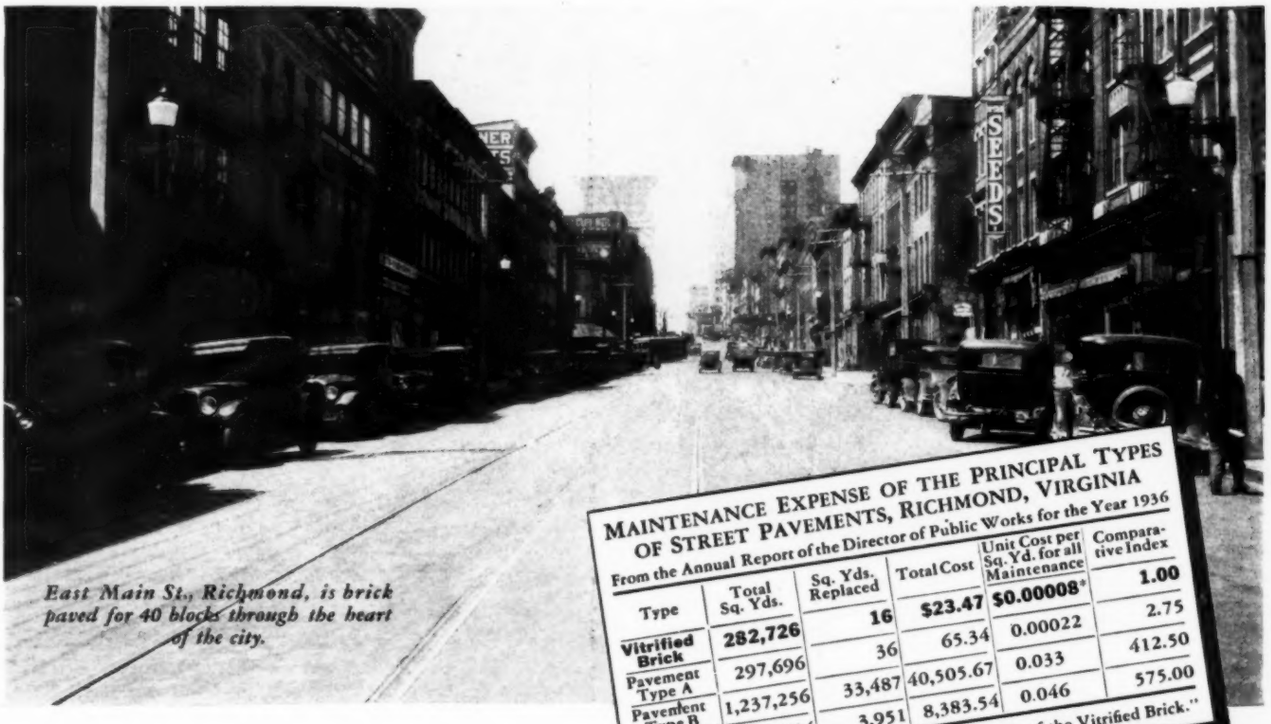
4. *The determination of the final quotients Q_s, Q'_s, and Q_c.* These factors are obviously determined from the data hereinabove outlined and the formulas hereinabove given.

$1^{00} = $2^{75} = $412^{50} = $575^{00}

(or)

Pavement Maintenance Costs

at RICHMOND, VA.



East Main St., Richmond, is brick paved for 40 blocks through the heart of the city.

MAINTENANCE EXPENSE OF THE PRINCIPAL TYPES OF STREET PAVEMENTS, RICHMOND, VIRGINIA

From the Annual Report of the Director of Public Works for the Year 1936

Type	Total Sq. Yds.	Sq. Yds. Replaced	Total Cost	Unit Cost per Sq. Yd. for all Maintenance	Comparative Index
Vitrified Brick	**282,726**	**16**	**$23.47**	**$0.00008***	**1.00**
Pavement Type A	297,696	36	65.34	0.00022	2.75
Pavement Type B	1,237,256	33,487	40,505.67	0.033	412.50
Pavement Type C	180,984	3,951	8,383.54	0.046	575.00

*"Maintenance due to causes other than the failure of the Vitrified Brick."

● Of course, you've always known that of all the pavement types, brick is far less expensive to maintain. But how those official figures for Richmond, Va., give point and definite form to an old truth!

Brick maintenance for 1/575th of the maintenance cost of another well-known type is quite a lot of difference!

So. 2nd Street was brick paved last year.

Brick pavements are now in daily use after nearly 50 years of exposure to weather and traffic. With such a long life and such a low maintenance, brick is indeed the greatest of all paving values!

The reason for long life and low cost of brick pavement is due to the fact that it withstands weather as well as traffic. Changes in temperature and atmospheric moisture damage most pavements. Brick is more highly resistant to these natural causes of damage than any other type. In addition it is highly resistant to traffic damage.

Use vitrified brick on new jobs. Various types of old pavement may be easily resurfaced with brick. National Paving Brick Association (Affiliated with Structural Clay Products Institute), National Press Building, Washington, D. C.

BRICK

FOR NEW AND RESURFACE JOBS

Exhibitor: Highway Exhibit, American Road Builders' Association, January 17-21, Cleveland, Ohio.

CALLING KGHB—CALLING KGHB CLEAR SLIDES AT AIRPLANE CURVE

Two-way Short Wave Radio Control Proves Effective in Snow Removal in Washington

STUDY of short wave two-way radio communication for control of snow plow activities was started by the Washington Department of Highways in the winter of 1932-33 under the supervision of the Director of Highways, Mr. Lacey V. Murrow. The ambition at that time was to get a setup that would be efficient and economical for the control of mobile units and at the same time establish communication with the outlying and remote sections of the state.

First installations were made during the winter of 1933-34 as fixed stations at the summit of Snoqualmie Pass, at Crystal Creek camp in Chinook Pass, and in the District Headquarters office at Seattle. Transmitting and receiving sets were also installed in two snow plows operating in Snoqualmie Pass. This road is kept open all winter.

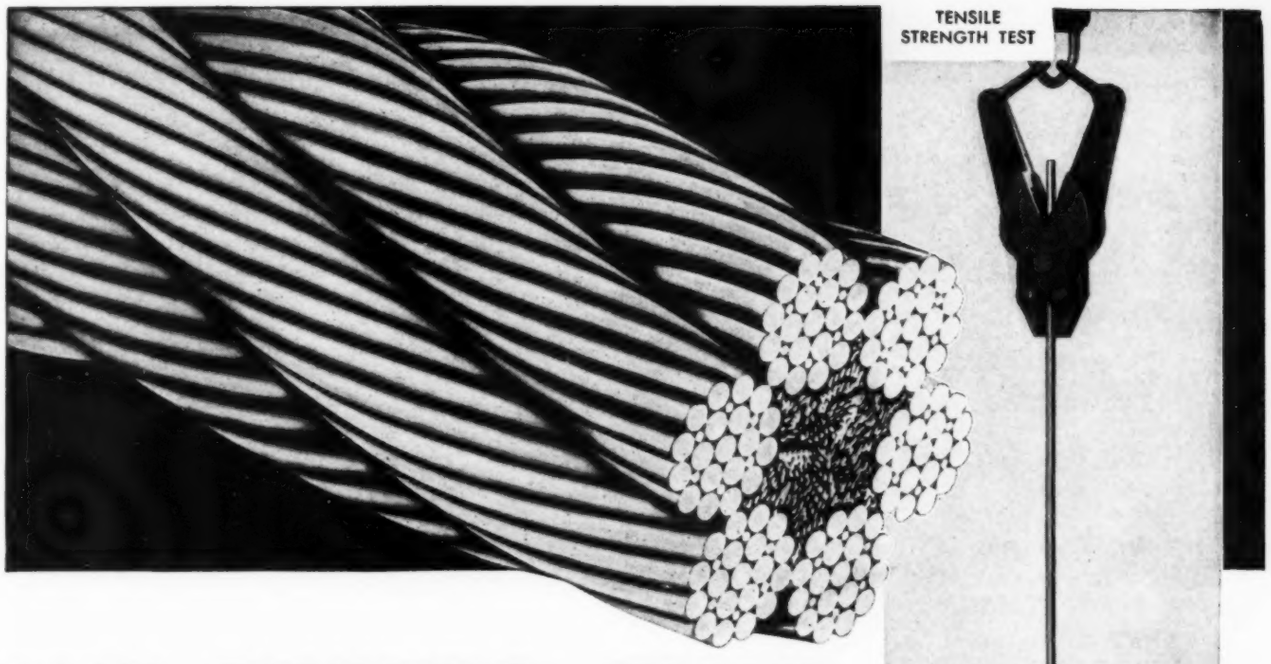
After a short time of service this method of radio communication was found to be of such advantage that steps were taken to install a network covering the various other district headquarters' offices and all important mountain passes. Several remote sections that had either no wire communication whatever, or because of poor condition of wire lines had unreliable service during stormy weather, were also included in the network. All rotary snow plows were also equipped with two-way radio equipment.

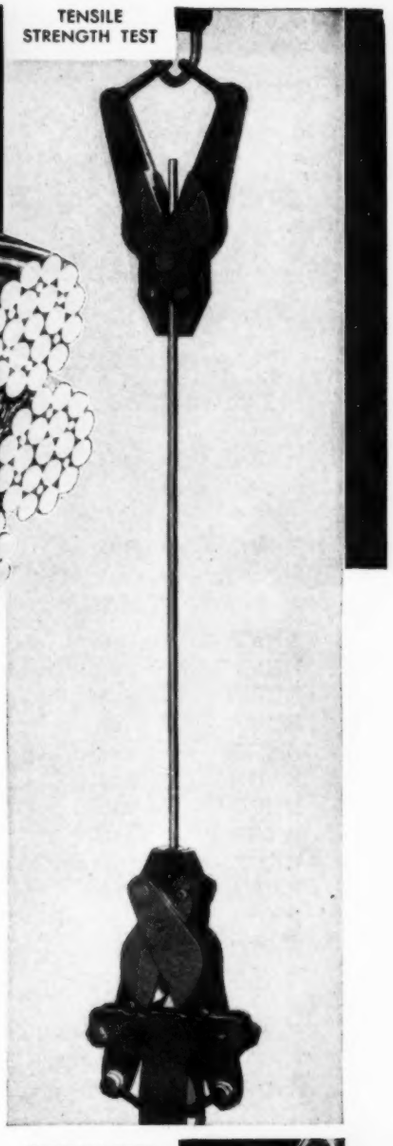
The Radio Network

The network of fixed stations are as shown on the accompanying map. Following is a list of the stations that are operated:

No.	Call Letters	Location
1	KGHA	Snogo A-232 Snoqualmie
2	KGHB	Snogo A-241 Snoqualmie
3	KGHC	A-217 Snoqualmie
4	KGHD	Seattle
5	KGHE	Summit
6	KGHQ	Crystal Creek
7	KGHR	Car A-13
8	KNFC	Patrol Boat "Stevens"
9	KNFD	Patrol Boat "Rogers"
10	KNFG	Olympia
11	KNFK	Bellingham
12	KNFL	Shuksan
13	KNFQ	Skykomish
14	KNFR	Snogo A-248 Chinook
15	KNFS	Snogo D-186 Stevenson
16	KNFT	Snogo B-292 Blewett
17	KNFU	Snogo A-227 Mt. Baker
18	KNFV	Snogo E-28 Snoqualmie
19	KNFW	Snogo E-800 Easton
20	KNFX	Ellensburg

Radio equipped snowplow at Chinook Pass.





WE TESTED THIS 450 TIMES

To prove its Quality

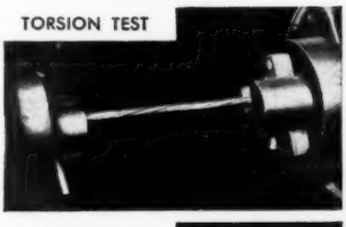
JUST as each part of a well built machine* must be tested individually before it is accepted, so each individual wire in American Tiger Brand Wire Rope is tested at least 3 times, in addition to test for size, before it can pass to the stranding machines.

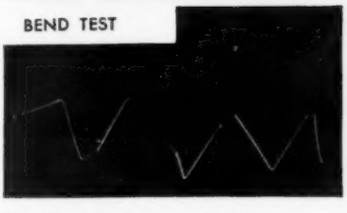
Your work puts wire rope to the severest tests. It must string or reeve easily and quickly . . . spool well . . . avoid whipping at high speeds . . . take the terrific jerks of starting and stopping.

And it is these qualities in American Tiger Brand Wire Rope which have given it a dominant position in the field—qualities which have been built into it by engineers whose wealth of experience is backed by over 100 years of wire making.

American Tiger Brand Wire Rope is available in either Standard (non-preformed) or Excellay (preformed) constructions.

***USS American Tiger Brand Wire Rope is a machine, more depended on than many. It fits the definition "Any combination of mechanism for utilizing or applying power."**





AMERICAN TIGER BRAND WIRE ROPE

American Tiger Brand Wire Rope. Electrical Wires & Cables. Amerclad All-Rubber Cables. Aerial Tramways. Tiger Wire Rope Slings. Tiger Wire Rope Clips.

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COLUMBIA STEEL COMPANY
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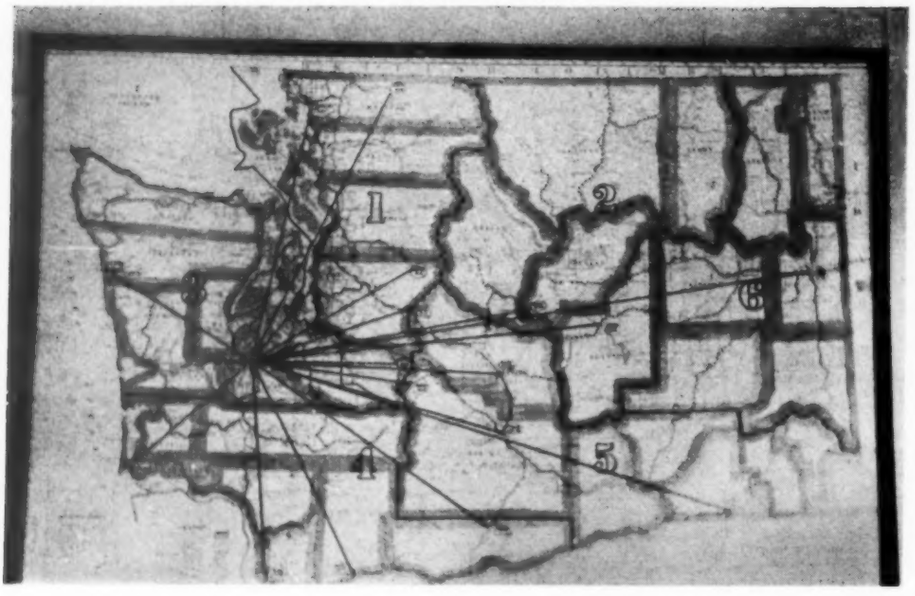
United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

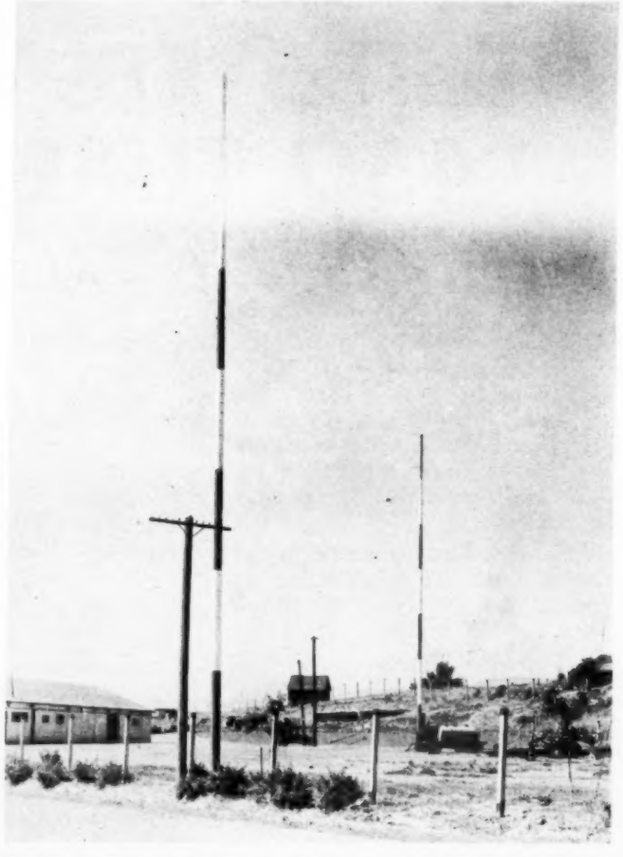


Radio Control Net for Snow Removal Activities of State Highway Department of Washington. Headquarters are at Olympia and Close Contact Is Kept Every Minute Throughout the 24 Hours of the Day.

21	KNFY	Bear River
22	KNFZ	Hell's Crossing
23	KNGA	Satus Pass
24	KNGB	Yakima
25	KNGC	Vancouver
26	KNGD	Walla Walla
27	KNGQ	Wenatchee
28	KNGR	Spokane
29	KNGZ	Ephrata
30	KNHA	Patrol Boat "Ferry"
31	KACB	Snogo B-408 Stevens Pass
32	KACG	Snogo G-727 Davenport
33	KACH	Genoma
34	KACQ	Klalock
35	KACW	Headquarters Car No. 1 Olympia
36	KADU	Aeroplane N.S. 665K
	KHAYW	Aeroplane N.S. 665K (3105 K.C.)

Several trucking companies, garages and automobile clubs have short wave receiving sets and keep posted at all times on road conditions. This method of communication has saved its cost of installation several times over. Later the network was used for intercommunication of district offices with headquarters.

KNFG—Headquarters Radio Room at Olympia, Washington, State Department of Highways.

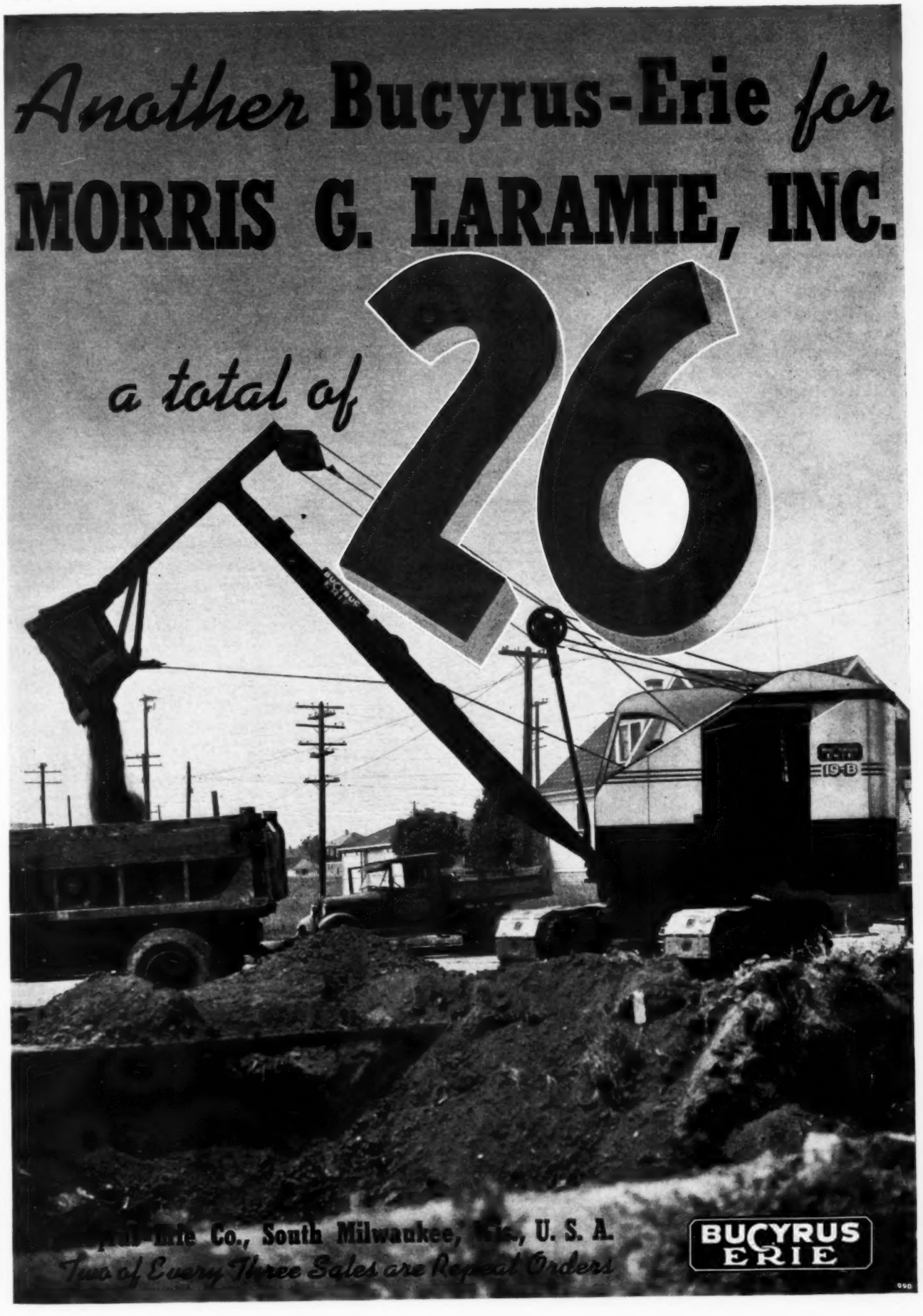


Aerial at Fixed Station in Ellensburg Division Equipment Shops and Yard.

How Radio Control Works

To illustrate the practical utility of this method of control, following are some excerpts from road reports:

Jan. 21—2:45 A. M.—Report received at Summit that 9 trucks, 2 push plows and 2 passenger cars were caught


Another Bucyrus-Erie for
MORRIS G. LARAMIE, INC.
a total of 26
Co., South Milwaukee, Wis., U. S. A.
Two of Every Three Sales are Repeat Orders
BUCYRUS ERIE

by slide. (Snoqualmie Pass). One truck is caught under the slide and balance of vehicles are between slides. Snoge A-241 called by radio and directed to go to scene as soon as possible. Slide at Airplane Curve-West.

5:10 A. M.—Snogo nearing slides. Calls Summit to find out which side of road trucks are on so they can avoid running into them with the plow.

6:00 A. M.—Snoge reports they have passed through one side and are just coming to another. Have not come across any vehicles yet.

7:00 A. M.—Snogo A-232 now OK and heading down west side. A-241 plowing near Denny Creek headed up.

2:15 P. M.—Snoqualmie Pass. Slides still coming worse than ever. Road still closed. Do not know when it will be open. Slides are at Airplane Curve. Average height of slides up to top of cutter bars. Have not reached trucks in slide.

Jan. 22—2:20 P. M. Three slides at Airplane Curve. Expect one way traffic in five or six hours. Road open Summit to Easton. Narrow at Hyak.

8:10 P. M.—75 feet of slide left.

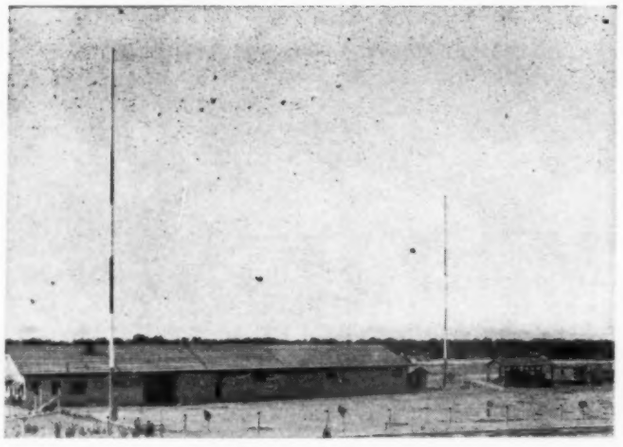
9:35 P. M.—60 feet of slide left.

Jan. 23—12:01 A. M.—Passageway through slide at 11:45. Now widening to permit one way traffic.

1:30 A. M.—One remaining truck in slide across one-way traffic lane. Cannot start traffic until wrecker removes.

5:30 A. M.—First traffic arrived at Summit at 5:15 A. M. Will take about two hours for trucks to pass through.

Snowplow at Work in Snoqualmie Pass.



Aerial Erected in Maintenance Yard.

Jan. 24, 9:00 A. M.—Snoqualmie Pass open for two-way traffic.

The Radio Setup

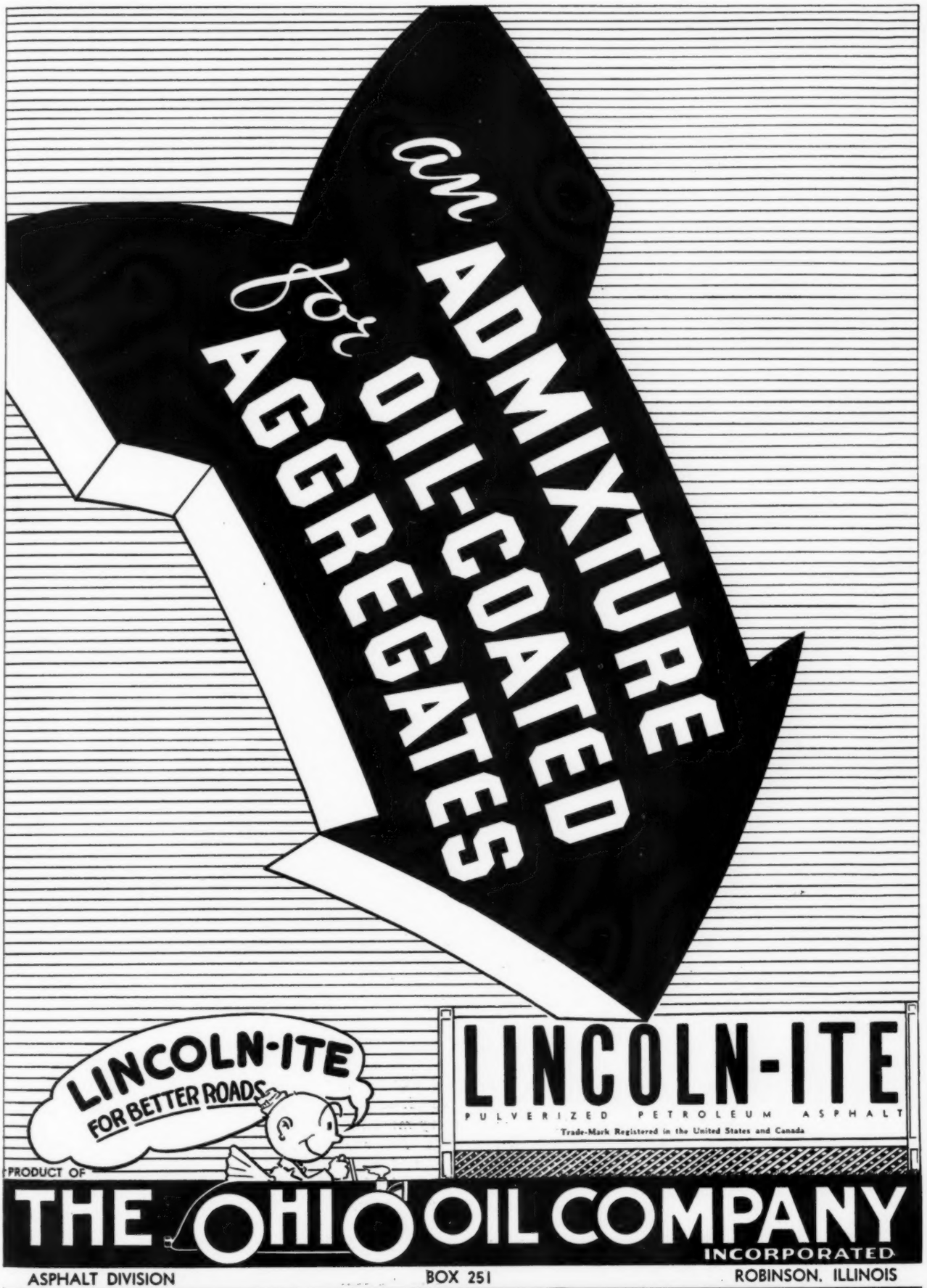
At the present time the setup consists of 20 fixed stations, 8 of which are of 50-watt capacity and 12 of 10-watt capacity. There are 16 mobile stations each equipped with 10-watt transmitting and receiving sets. In addition to these the business passenger cars of the district engineers, district maintenance engineers, district supervisors and the various department heads at Olympia are equipped with short wave radio receiving sets which are fixed to the frequency at which the state is licensed to operate by the Federal Radio Commission. So equipping these cars has proved to be a decided convenience as it enables the operator of the car to be called to long distance telephone in case of necessity for two way communication.

Operation of this system is continued at practically no expense for special operators. Shop clerks are encouraged to become licensed radio operators, as required by the Federal license, as are operators of special equipment. These men thus carry on their regular duties while operating the radio equipment.

Many times have the engineers ordered by radio a snow plow moved from one place to another to assist in keeping a pass open or to clear blocked roads. Snow slides are the troublesome work in snow removal. A pass may be cleared and traffic start to flow only to find that a little later the pass has been blocked again by a slide. Cars and trucks are often only detained for hours now, because of radio, where they formerly were marooned for days.

▼

BRICK PAVEMENT MOTION PICTURES—The Division of Motion Pictures of the Extension Service, U.S. Department of Agriculture, Washington, D.C., has made the following new pictures: Brick Pavements—1 reel (Silent) (35mm. and 16mm.) shows methods and machinery used in making brick pavements; Making Paving Brick—1 reel (Sound and Silent) (35mm. and 16mm.), shows the progress of clay, from the time it is taken from the deposit to the finished product.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WINTER ROAD MAINTENANCE IN QUEBEC

By ALPHONSE GRATTON

District Engineer, Provincial Roads Department, Quebec

WINTER maintenance is easy and cheap enough in the southern states but is harder and more difficult and costly in northern countries such as Canada, where the climate is more severe, the snow-fall heavier and the taxpayers less numerous. To what extent should winter road maintenance apply at present to the system of improved roads of the eastern Canadian provinces? It is obvious that to gain public favor such maintenance should answer a real need and be justifiable economically.

I understand Ontario is maintaining 3,000 miles of winter roads, mainly in the southern part of the province where the population is dense and the annual snow-fall not over 50 or 60 in. on an average. In the province of Quebec, 600 miles were maintained for the last two winters, in the Montreal, Quebec, Sherbrooke and Chicoutimi districts, none of them however, being linked together. The average cost of this maintenance has been $291 per mile for the winter of 1935-36, when the snow-fall was 64 in. in Montreal and 108 in. in Quebec. To refund this cost from the gasoline tax at 6c a gallon, it would have required an average daily traffic of 632 cars, which is easily reached in the Montreal district, but not in the others. This explains why winter maintenance is more extensive around Montreal, where it is a paying proposition, but not so in the rest of the province, where it would be unfair to have maintenance expenses paid by others than the users of the roads.

Effect of Location and Design in Drift Prevention

I think that in highway location and design more thought should be given to winter road maintenance. It would then be possible to do away with much snow drifting or facilitate its removal from the roadway.

(a) The alignment, chiefly on cuts, could be chosen as much as possible in the direction of the prevailing winds, thus avoiding heavy snow-drifts and allowing the road to be cleared by the action of the wind.

(b) The grade line could be set at about 18 in. above the adjacent ground level so as to receive the full benefit of the sweeping action of the wind.

(c) The shoulders, ditches and slopes should be designed wide and easy in order to provide ample storage space for snow and offer the least interference to the free passage of the wind. Sections in a cut should also be made wide and shallow by increasing the width of the right of way if necessary.

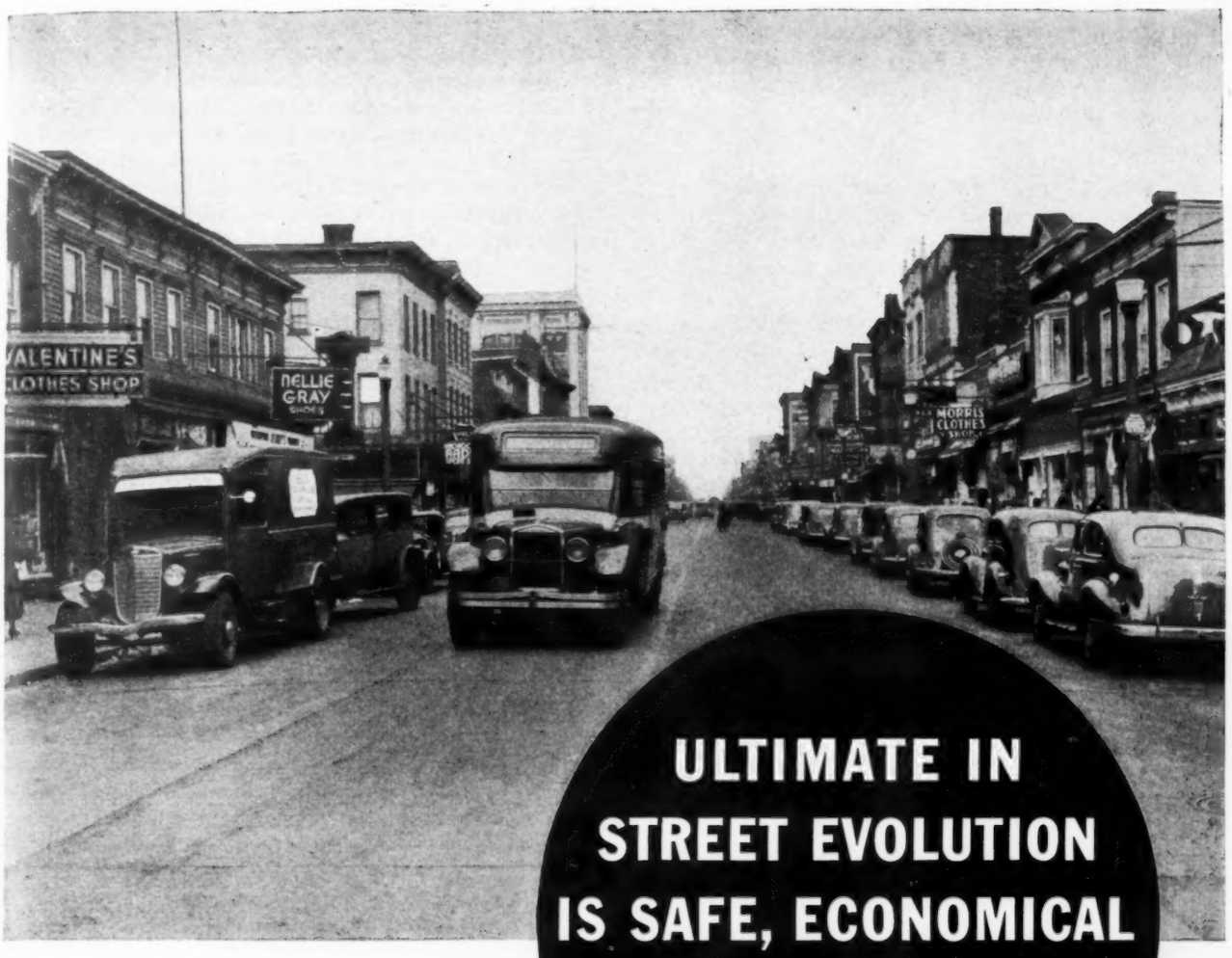
(d) The road should follow low altitudes or valleys where it is less exposed to snow-drifts or severe storms than in the open. The road should also take advantage of natural protection against snow as in wooded country along deep ravines or sharp ledges which are real snow-traps. A survey made in the winter will disclose all spots exposed to snow-drifts and allow the study of a possible location to avoid them.

Snow Fences

The usual way of preventing snow-drifts on the roadway is to use artificial snow fences. In Quebec we use a vertical slat type, 4 ft. high, easy to install and easy to store. This fence is placed at every drift spot, after close observation of the road; the total length being about 20 to 30 per cent of the mileage of road maintained. The proper distance of this fence from the roadway varies from 60 to 75 ft., as it is admitted that the drift caused by the fence is about 15 ft. long for each foot in height of the fence. The underside of the fence is placed 6 in. from the ground to prevent it freezing in and to allow for raising if necessary. If properly located, against prevailing winds, this fence will avoid much plowing and largely justify its cost, which is about $50 per mile of road maintained.

Preparedness Secret Of Snow Removal

The secret of success in snow removal is preparedness. No two winters are alike and each one offers new problems to solve. It is all very well in the fall of the year, on a bright sunny day, to be optimistic in preparing a plan for the coming winter; but experience teaches that one should always be prepared for the worst. The program of roads to be kept open should be all ready by November so as to start cleaning with the first storm. There is nothing as hard on men and equipment as to try opening, in mid-winter, a road that has been blocked for weeks and where the snow has turned almost into ice. It is a sure way of crippling an equipment at the very moment when it will be badly needed on its regular run. All trucks and plows should be overhauled in the fall and put in first-class running order; snow-removel being the hardest test on a truck on account of severe conditions under which it has to operate. Fall is also the time to buy new machinery if required, and not wait until all roads are blocked and you have to rely on immediate delivery, when you find that everybody else is doing the same. Plows, whether fixed or rotary, should be removable so as to allow the truck to be used on other



ULTIMATE IN STREET EVOLUTION IS SAFE, ECONOMICAL

Concrete

Broadway, Bayonne, N. J., now paved with concrete over its 3-mile length. Heavy traffic was handled and fire protection assured by keeping at least one lane open during construction. High early strength cement concrete permitted early use of new pavement. Designed and built under direction of Walter L. Clarkson, city engineer.

• Half a century ago, Bayonne's main street was a plank road. Then, like many a street, it was paved, repaved, and repaired until further maintenance became an economic burden.

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PORTLAND CEMENT ASSOCIATION, Dept. 10-28, 33 W. Grand Ave., Chicago, Ill.

A National Organization to Improve and Extend the Uses of Concrete

work during summer season, otherwise depreciation and interest on investment will bear heavily on winter maintenance.

Personnel and Equipment

Probably the most difficult part of preparing for a snow-fighting schedule is the training of a personnel to handle the equipment. For each plow outfit it is important to have three good operators who are familiar with the roads to be covered. These men should not be afraid of work and should have the physical qualifications necessary to put up with long hours and the discomforts of battling a storm, often in biting cold. Properly selected and trained reserve helpers are also needed, capable in an emergency to replace the operators.

The selection of equipment is very important and I do not think that any one type of machinery can be applied universally to all situations and be able to handle them economically. Fighting snow-storms requires fast-moving equipment, such as the truck type with displacement plows. Weight and power of truck, type of truck and plow as to speed or heavy duty is dependent on local conditions. In Quebec we use chiefly heavy 4-wheel-drive trucks from 3½ to 7 tons, fitted with V-plows and supplemented with rotary plows of the auger and blower type. A few light fast trucks are used in light snow-falls or to clean up behind heavy units. The 4-wheel-drive trucks do the heavy work of moving drifts to the side of the road, as far as possible over the shoulders and ditches; then, after a storm, these trucks are followed by rotary plows to blow the snow banks into adjoining fields, so as to leave no snow ridge above the level of the roadway. If this blowing is not done, drift removal will become costly, the plowed width of the road will get narrower with the advance of the winter, and widening by hand labor may have to be resorted to.

Each heavy truck has a motor of 100 to 125 h.p. and has a beat of 25 miles as an average. The rotary plows cover 80 miles per unit in the Montreal district and only 30 miles around Quebec City.

The time element is in several ways a big factor when a storm is impending. It should be anticipated that the visibility will become very low for the driving of trucks and perhaps impossible for night work. It is, therefore, essential that the plant and personnel be ready for a quick start. Relief of operators must be arranged so as to leave no let-up until all roads are cleaned. Contact must be maintained with all units by telephone or otherwise so as to be able to move them, if necessary, where they are most needed. During the height of the storm it may not be possible to maintain some essential part of the system open to traffic. In such instance, it is essential that powerful units be constantly available for relief or additional help.

Any dry snow, under 6 in. thick, might be cleaned easily with a light truck and a 6-ft. V-plow. If allowed to pack, freeze or drift, this same snow will require a heavy truck and plow and will cost three to five times more. If allowed to block the road, a rotary plow might be needed, but this process is slow and liable to raise the cost 10 to 20 times more. Therefore, the rule is to clean roads at the earliest opportunity, while the snow is light and easily moved.

Ice Treatment

After opening the road, the duty of highway officials is to make driving safe at all times. That brings up the problem of ice treatment. In this case again, there is no fixed rule to handle this new problem. There are several causes of icy pavements: First, wet snow falling on the road may be compacted by traffic and turned to ice by alternate freezing and thawing. Second, when snow turns to rain and the resulting slush is not removed in time, it will eventually turn to ice with a lowering temperature. Third, sleet storms will also cover rapidly all pavements with ice.

In the first case, of wet snow, the plow operators are instructed to scrape it off the road as fast as possible before freezing. A useful equipment in such a case seems to be a light truck with an underbody blade mounted on springs used for summer dragging, which allows the quick and complete removal of wet snow.

In the case of sleet, there seems to be no equipment yet known that can remove the ice effectively. So far the only remedy is to use sand or other abrasive, mixed with calcium or sodium chloride. About 2 or 3 per cent of this material added to stockpiles prevents them from freezing and allows the sand to be embedded in ice and realize a truly non-skid surface.

The sand has to be stock-piled ahead at various spots along the road and for fast application has to be loaded and spread mechanically. To insure success in this line, it requires organization and equipment, because quick action is essential on the whole system of roads at once. When the ice thaws out, sand must be removed from road surface because abrasive is detrimental to road surface and specially the chloride mixture on concrete pavements where an excess seems to cause it to scale. This ice treatment may cost $10 to $15 a mile per application of sand, and its use in Quebec has been confined to most dangerous spots, such as highway and railway crossings, bottoms of hills, sharp curves, bridge approaches, etc.

Acknowledgment—The foregoing is an abstract of a paper presented Sept. 9 at the 23rd annual convention of the Canadian Good Roads Association.

▼

TEXAS ROAD BOND LAW EXTENDED FOR TWO YEARS—Governor Allred has approved the bill extending for another two years the county and district road bond indebtedness law. Under its terms 1 ct. of the 4 ct. gasoline tax is applied to the payment of interest and principal of road bonds issued by counties and districts where the proceeds were used in the construction of designated State highways. The assumption starts with issues antedating Sept. 17, 1932.

▼

AVERAGE GASOLINE TAX IS 5.5 CT.—The average tax on gasoline in the United States was 3.8 ct. per gallon in 1930; today it is 5.5 ct. per gallon, an increase of 45 per cent in the average rate of taxation. Approximately two-thirds of that increase is accounted for by the federal gasoline tax, enacted in 1932 and duplicating the taxes levied by the states. One-third of the increase in the average tax rate represents tax raises by the states, which, however, have been comparatively few since 1932.

LOW COST ROADS and BRIDGES

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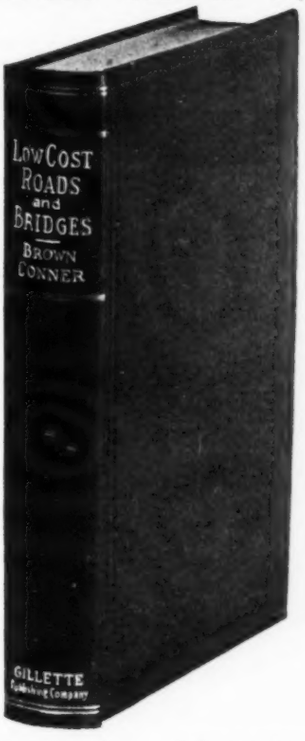

by

V. J. BROWN, C. E.
Publishing Director, Roads and Streets, Asso. Mem. Am. Soc. C. E., Mem. Western Soc. Eng., Mem. Am. Road Bldrs. Assn.

C. N. CONNER, B. S. in C. E.,
Chairman, Department of Design, Highway Research Board. Formerly Engineering Executive, Am. Road Builders Assoc. Mem. Am. Soc. C. E.

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Congress made this book particularly useful. How? The passage of the Hayden-Cartwright Act authorized $25,000,000 for farm-to-market road work for each fiscal year 1937-38 and 1938-39. The act requires the money to be matched, thereby making $50,00,000 available for each of those two years. This book is a technical treatise on low cost road and bridge design and construction and covers just the type of work expected to be done on the farm-to-market roads.

In ten well-arranged chapters the authors have covered the fundamentals of highway design, economics and planning, grading, surface treatment, low-cost paving materials and their testing, inspection and maintenance. An additional chapter discusses highway bridges. Although the book is not overloaded with illustrations, there are enough to make clear the text.

In a work of this kind, one would not expect to find any discussion of the more expensive types of surfacing —sheet asphalt, brick, stone block, etc.—nor does it appear. The treatment of the lower types, however, is entirely adequate. The authors have not hesitated to enlist the cooperation of a number of specialists, which adds much to the value of their book.

The text is so written that it can be used as a field book for actual construction. Step by step processes are described. Of particular value are the discussions on tar and asphalt and the interpretation of tests of these bituminous materials. The manufacture of bitumens for road work is explained. Other useful information is the section which explains what the various trade named and patented product materials are and their distinguishing characteristics.

Engineering of low cost construction and economics of highway types are thoroughly treated. In compiling the text matter Messrs. Brown and Conner state—"The authors' problem was one of selection, correlation and synthesis, rather than research, experiment and analysis." The book belongs on the desk of every engineer and contractor doing road work.

All the types of low cost surfacing processes are discussed and denfiite "best practice" methods are explained in detail. When considered in conjunction with the discussions on economics, the text indicates definitely what type of improvement is the most economical for a particular road. In fact, herein lies the greatest value of the book—helping the engineer or executive to decide what type of improvement would be the most economical under particular local conditions. The national traffic and highway planning survey will indicate that for economy, many state highways should be improved by some low-cost surface rather than a high type of construction. For this work this book will prove valuable far beyond its cost.

The authors of this volume were far-sighted enough to know that for future construction the economics of highway types would play an increasingly important part in improvement programs. They have, therefore, thoroughly discussed this phase of highway planning.

The book is highly recommended as a criterion of low-cost road construction practices and methods.

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EDITORIAL

Flunk—No License

NOTHING drives home to the investigator who is studying our highway safety problems the weakest spot of the four units involved more than a long drive on the highways. The four units are the car, the driver, the pedestrian and the highway. By and large the most dangerous unit is the driver. In cities and congested areas, the pedestrian is second. In my opinion, the highway or street is third and the motor vehicle fourth.

The State of Washington is attacking the problem in a logical manner. At the last legislature a modern highway code was adopted one section of which was devoted to driver's license. Enforcement is the order of day in Washington.

Even a short drive over Washington's highways will quickly show the investigator that the Evergreen State is building safety into them. Talks with the engineers will convince one that highway safety and a reduction of the toll of death, injury and destruction is a motivating force in the state highway department.

One day while the writer was preparing an article on Washington's new highway code, a woman took the drivers test at Olympia. She could only muster a grade of 40 per cent on the examination. She was quite put out and belligerent because her license to drive was refused. There is no "fix," so she had to go back home and study the motor vehicle laws and rules of the road some more. The state highway department has prepared a long list of questions and answers on the code and rules of the road. Each applicant must answer at least twenty-five of the questions which the examiner selects from the long list. A grade of at least 80 is required before a license to drive is issued.

The department is prosecuting an educational campaign by speeches, radio talks, pictures and newspaper articles. The Evergreen State will reduce the accident rate and take its place near the top of the list of states with "Safe Highways."

One point that drivers of cars often overlook is the simple fact that if they were the only ones going to the destination they have in mind there would be no road where they were. Since they are on a *road* it is quite possible that another car is on the same road and they should practice safe driving and follow the rules of the road.

Visible Handwriting

CALIFORNIA sees the handwriting on the wall relative to future transportation needs. At a recent meeting called by C. H. Purcell, State Highway Engineer, attended by department heads and the eleven district engineers, future construction of the divided highway for this state was discussed. They have learned from experience that by-passes act as such only long enough for the town to rebuild on the by-pass, so they are discussing the feasibility of enacting a policy governing the creation of free-ways as a part of the highway development in territories adjacent to metropolitan areas. The new dual highways may then function as fast arteries as planned.

The subject of vehicle clearance came up at the meeting. A print was displayed which showed two standard boxcars passing on standard railway double tracks. Beside this was shown two modern highway motor freight units passing. In the first case the clearance between sides of boxcars was 3 feet 6 inches; in the second case the clearance was only 1 foot 6 inches. Certainly the highway freight unit clearance is insufficient. In fact, for units of the size they are and the speed at which they travel, that clearance is dangerous.

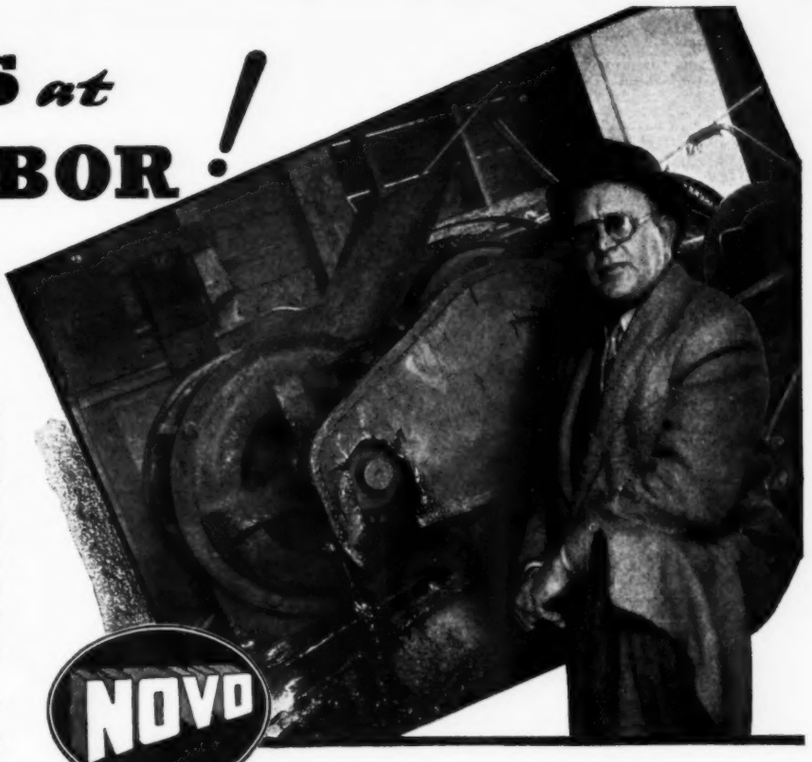
To overcome this on the new dual highways of California it is proposed that the inside lane of one half of the road be built 12 feet wide and the outside lane 11 feet wide. This will be the new standard for dual highways in California. Service roads are planned for the sides if a free-way policy is adopted.

We believe this to be an important forward step. One might ask, "Why not restrict the size of motor freight units, rather than build larger pavements?" The answer is not simple, but evidence of operations and investments in freight units today indicate that restriction would be a backward step. 'Twould be far more logical to restrict units larger than now operating and tax the large highway freight units sufficient that they will pay the additional cost of construction required to permit their operation.

▼

PUTTING THE BUMPS IN PAVEMENT—Having decided that motorists put a higher value on comfort than on traffic regulations, officials of a Maryland city, under orders of the council, will rip up a smooth pavement on a curve in the city's residential section, so that there will be bumps 2 in. high all the way across the curve, to prevent speeding.

12 YEARS at HARD LABOR!



NOVO HOIST *still at it!*

● A true veteran in length of service and work accomplished is this old Novo Dragline Hoist owned by Mr. O. W. Lundquist of East Detroit, Michigan, pictured above.

Since March, 1925, this hoist has worked practically every working day—has taken out about 1,000,000 cubic yards of gravel and has never been down for repairs, other than the replacement of normal wearing parts as, friction blocks and brake bands.

The hoist is still in daily service and shows no signs of weakening, demonstrating the number of years service Novo builds into their complete line of hoists.

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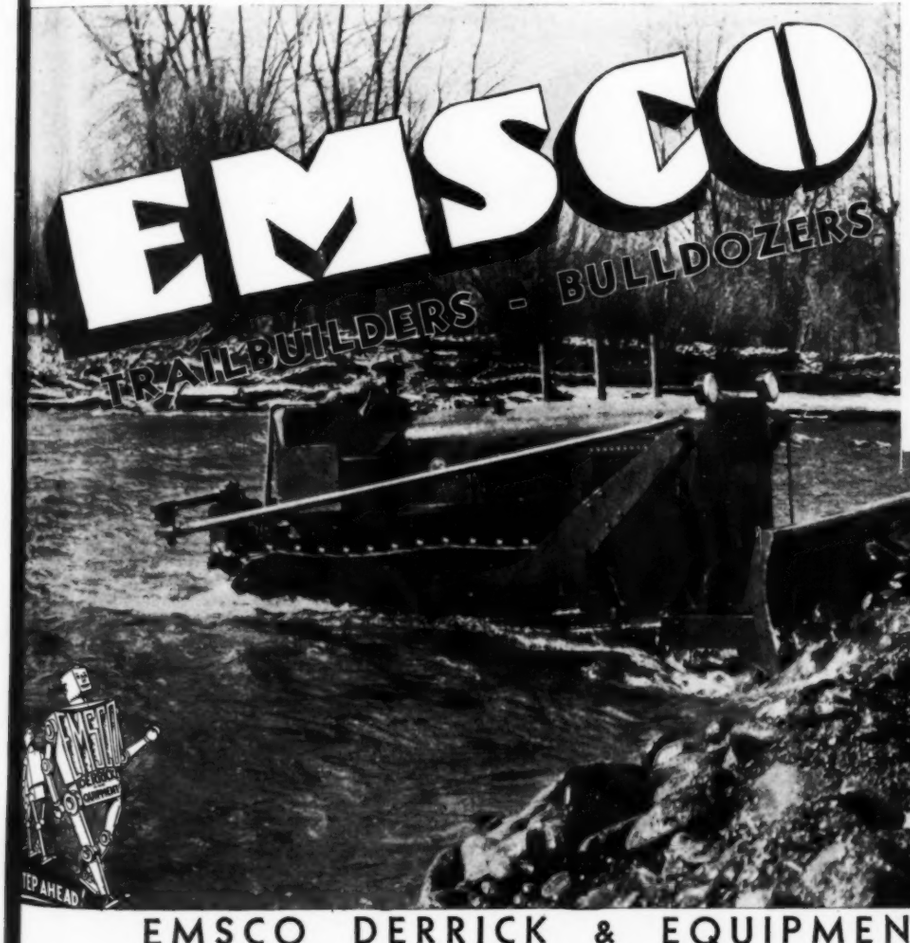

AGAIN proving the remarkable versatility, unfailing strength and endurance of Emsco tractor equipment, the Emsco (Model L A) Trailbuilder mounted on an Allis-Chalmers tractor, shown in the unretouched illustration, is being used to construct a coffer dam in the boulder-strewn Gunnison River, Gunnison County, Colorado.

Emsco Trailbuilders and Bulldozers assure outstanding performance on every job, without sapping or unbalancing the tractor's power. Their control is quick, positive and safe. The blade can be used in a bulldozing position (as shown in the photograph), or quickly swung to the proper angle for casting to either side. The Emsco patented tilting feature allows the blade to be tilted in either direction more quickly than any similar device now in use. ⟶ Write for bulletin Nos. 17-TA (Trailbuilders) and 18-TA (Bulldozers).

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New ¾-Yd. Excavator

A new ¾ yd. shovel—Model 303—has been announced by the Koehring Co., 3026 West Concordia Ave., Milwaukee, Wis. It is a high speed, light weight machine, designed according to the latest developments and progress of engineering skill. Koehring heavy duty construction has been employed throughout. The use of high strength special steels, combined with welded construction and simplified design has produced a machine of exceptional strength, with a substantial decrease in weight. It is stated to have remarkably high speed, great operating ease and exceptional traction and steering flexibility. The 303 is fully convertible, with a 1 yd. rating as a crane or dragline. Attachment changes are easily and quickly made on the job. Many special Koehring features are incorporated in this new, thoroughly tested, and proven excavator. A simple gear shift provides two selective swing speeds to best synchronize with the arc of swing and height of lift for increased output. Two traction speeds give greater power in tough going and faster speed in easy traveling. Positive steering for any angle is easily accomplished from the lever position in the cab. Full vision from the cab operating position assures maximum production. Safety glass protects the operator. Convenient and free accessibility of all parts is a definite time-saver when adjustments are necessary. Each shaft can be independently removed. Drums are equipped with quickly removable barrels. Gears are enclosed with run in oil bath. Anti-friction bearings eliminate power waste.

New Koehring 303 Excavator Operating in a Limestone Quarry

▼

Sidewalk Plow With Curb-Climbing Feature

To overcome the well-known difficulties of getting the front end of a wheel tractor snow plow over curbs, the Anderson Engineering Co., 81-85 Binney St., Cambridge, Mass., has developed the curb climber here illustrated in conjunction with the Anderson SW-37 sidewalk plow. The device is the outcome of several years experimental and development work.

In service the curb climber operates entirely independently of the plow itself, so that the plow meets the curb before the climber, and can therefore work to the very edge going either up or down. The climber is spring-mounted and equipped with a rubber tired wheel, so that when it meets the curb in going up, it thoroughly cushions the shock and raises the front wheels gently, thus permitting the rear wheels to continue operation without losing traction and spinning. The plow is designed in accordance with the latest practice, the mouldboard being shaped to effectively and easily roll the snow, and where necessary, to lift it over previously plowed windrows. The push frame is very substantial, and both this and the mouldboard are protected by an automatic safety trip device designed particularly for this service.

The plow is raised and lowered by a hand hydraulic lift. The device is low and compact and yet affords a very high lift. Full vision is therefore afforded the tractor operator.

▼

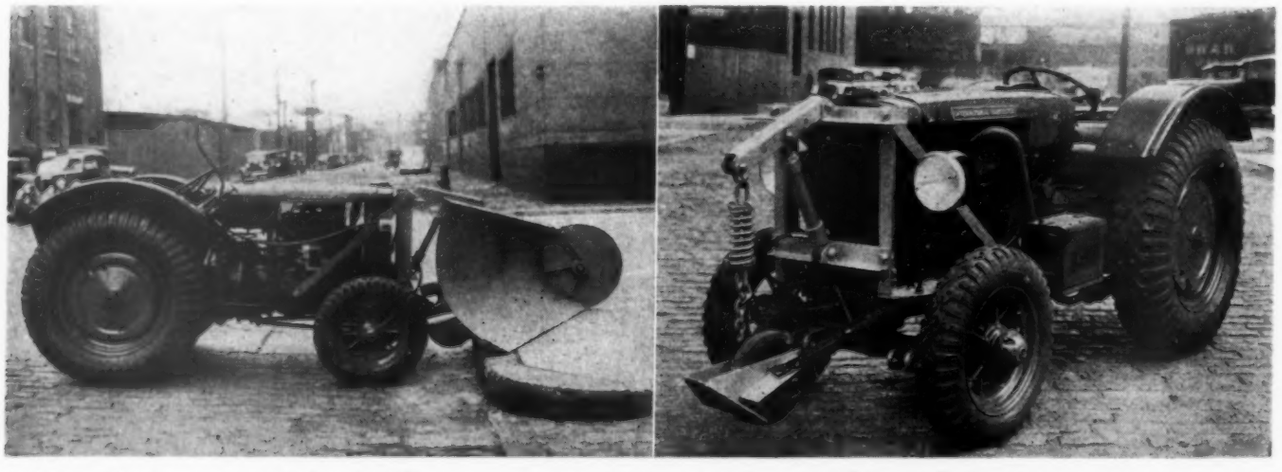
New Diesel-Powered Compressor

A new self-contained, Diesel-powered, 210-c.f.m. air compressor, available with several types of portable and semi-portable mountings, for a wide range of service applications, has been announced by Fairbanks-Morse & Co., 900 South Wabash Ave., Chicago, Ill.

The compressor unit has been kept light in weight and small in size, contributing to its portability. Ample bearing surfaces and proper lubrication makes possible a long trouble-free life. The water cooling system assures thorough and uniform cooling in any climate and under any condition.

The compressor is designed to operate at full engine speed, permitting direct-connection to the engine without reduction gears or belts and without sacrificing engine horsepower through reducing the rated speed.

The engine is a F-M Model 36-A, 4-cycle, 6-cylinder, medium-high speed Diesel.



Anderson Engineering Co. Sidewalk Plow on International Harvester Tractor Equipped with Goodyear Tires. Close-Up Showing Spring-Mounted Curb Climber and Hydraulic Lift Ready for Plow to be Attached.

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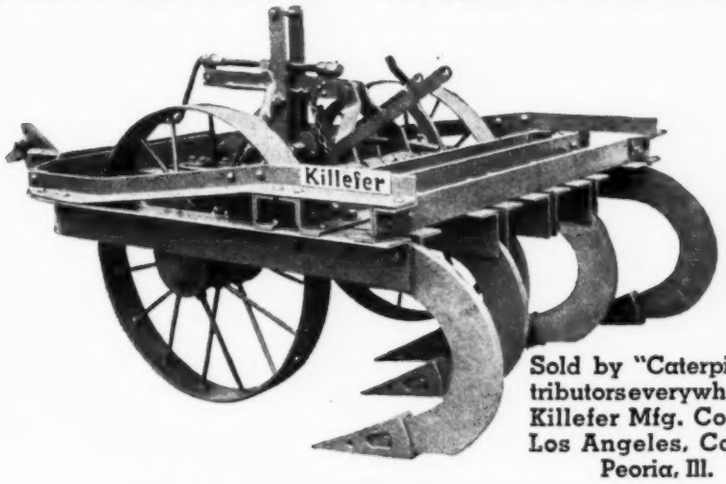
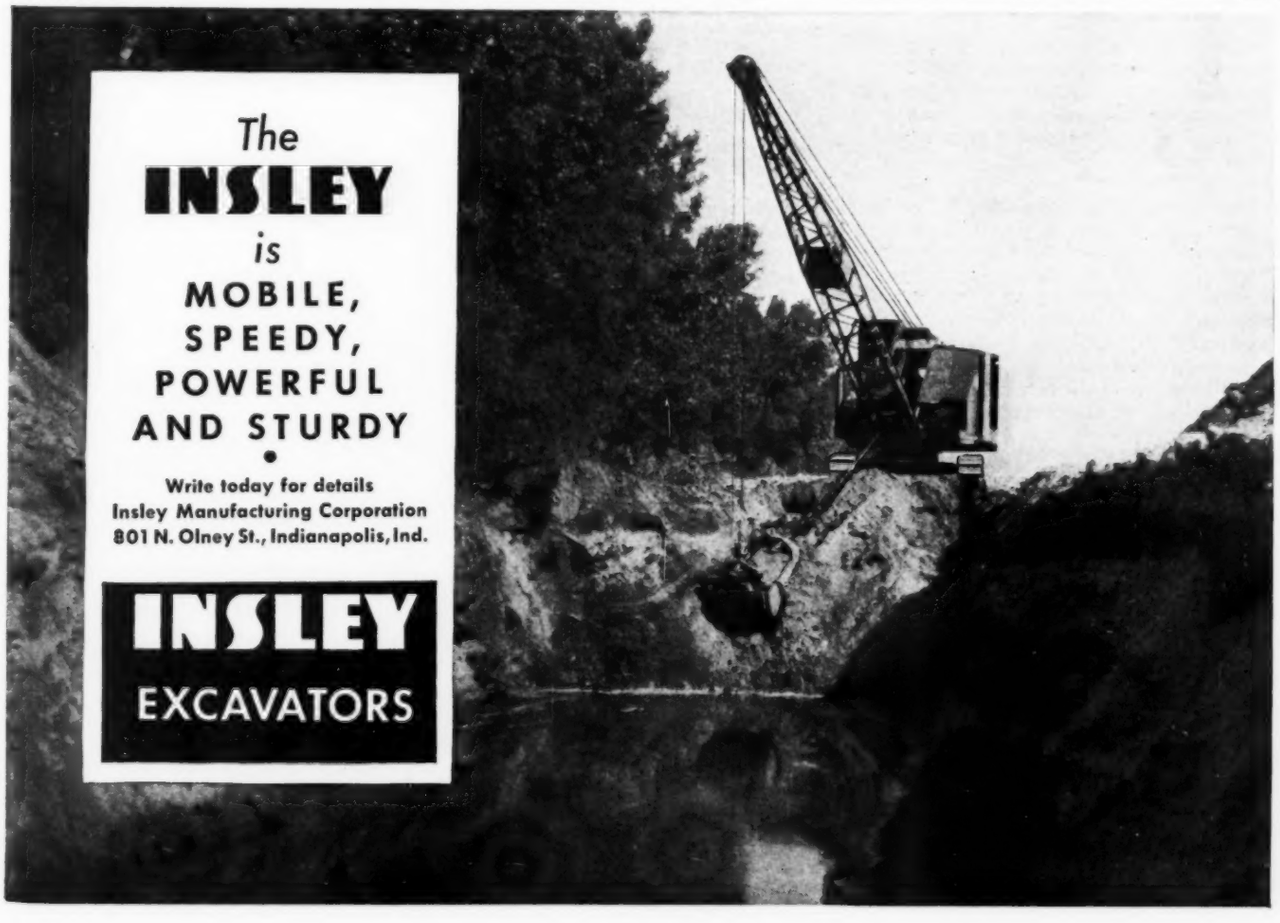
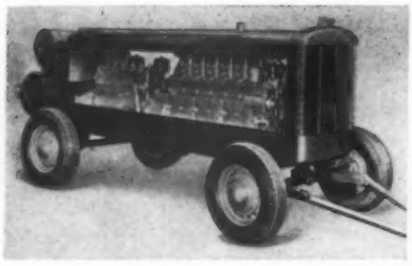
A POWERFUL medium-weight ground breaker built for long hard service. For tractors of 35 to 45 HP. Has five heat-treated standards and points spaced 12″ apart. Maximum working depth 12″. Lift mechanism is self-contained, simple and positive. Frame is hot-riveted, has generous clearance and is designed for short turning. Working depth adjusted by crank. Weight 3150 lbs. We also build lighter and heavier type rippers. Write for folder 22 DA.



Sold by "Caterpillar" distributors everywhere. Write Killefer Mfg. Corp., Ltd., Los Angeles, Calif., and Peoria, Ill.

No. 9 Ripper





New Fairbanks-Morse Diesel-Powered 210-c.f.m. air compressor with pneumatic-tired, four-wheel portable mounting

The new Fairbanks-Morse Diesel-powered air compressor is available with several types of mounting; wooden skid, steel wheel, solid or pneumatic rubber tired wheel, four- or two-wheeled trailer, and motor or railway truck. Specifications will be found in Bulletin 3645-A1, available upon request from Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.

▼

New Bridge Flooring

A new bridge flooring—U.S.S. I-Beam-Lok Open Floor—has been placed on the market by the Carnegie-Illinois Steel Corporation, Pittsburgh and Chicago, a subsidiary of the U. S. Steel Corporation.

This floor is very similar to the well-known U.S.S. I-Beam-Lok Floor. It consists of special, extra-depth 5 in. beams which form the elementary load-carrying members. These beams are spaced 6 in. centers, with carrying 1¼ in. x ¼ in. cross bars intersecting at 3 in. intervals —which in turn are notched at the top to receive two additional supplementary cross bars ¾ in. x ¼ in. spaced equally between the main carrying beams. The entire assembly produces a steel surface with rectangular openings approximately 1⅝ in. x 2¾ in.

Among the advantages claimed for the new floor are:

It can be applied directly to stringers without supplementary supporting steel where the stringer spacing is not in excess of 4 ft. or 4 ft. 6 in. centers for H20 loading.

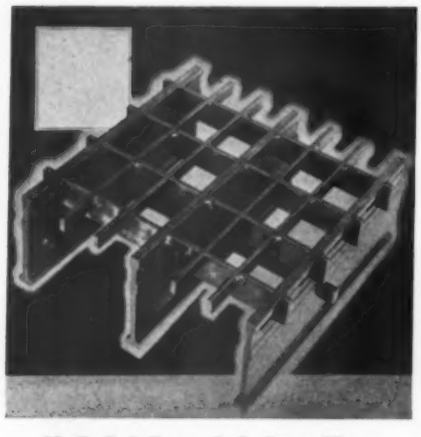
Long life is assured by a construction with no sections less than ¼ in. thickness. The I-Beam webs below the cross bars are thickened approximately 25 per cent to reduce bearing pressures.

This floor is light but strong—has a total weight above the stringers of 18.3 lb. per square foot.

Self-cleaning, rectangular openings 1⅝ in. x 2¾ in. have been so designed that there are no re-entrant angles. There is no chance of clogging with dirt, debris, snow or ice. Lower cleaning costs insure operating economies.

Material is fabricated in standard widths up to 6 ft. 1½ in., lengths up to 49 ft., which reflects speedy handling and low erection costs. Units may be placed so that main carrying beams run either parallel or at right angles to traffic.

Due to its light weight, it can be used to replace wood floors without sacrificing live load capacity of the bridge and, in some cases, will even secure increased capacity due to the fact of its greater strength as compared to the wood flooring.



U. S. S. I-Beam-Lok Open Floor

▼

Walter Snow Fighters

The latest development in the Walter snow fighter is illustrated herewith. These fighters are a special type of Four Point positive drive, heavy duty motor truck chassis, designed and developed to give efficient snow removal service under all snow conditions.

The traction is obtained through the use of three automatic lock or torque proportioning differentials, that deliver power to the wheels in proportion to their traction or ability to pull or push.

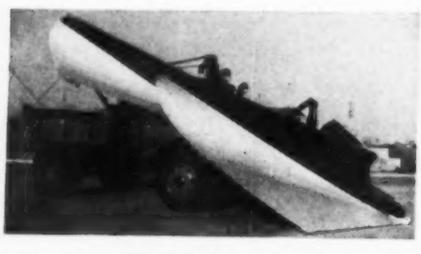
The motors are specially built heavy duty six cylinder motors, developing 150 and up to 200 HP for special services. The transmission system provides either a five forward speed and one reverse; or for special work, a six speed forward and two reverse, giving an unusual range and proper spacing of all gear ratios.

The final drive is the Walter patented suspended double reduction drive, which is stated to provide maximum capacity for heavy duty work, and minimum unsprung weight; the drive mechanism being suspended in the chassis and entirely clear of the axle or load carrying members.

The special coupe cabs are extra large and roomy, and provide proper comfort and vision for the operator.

For highway service, the trucks are generally equipped with either a center or offset type of high lift V-plow. These plows push directly to the front axle and ride on the road as an independent unit.

The side wings are of the front mounted type, to give the proper balance of side thrust, and can be lifted to very high



Unit with Offset V-Plow and Wing for Highway Service

Unit with 1-Way Speed Plow and Center Pressure Snow Blade for City Service and Arterial Highway Service

positions for work on high snow banks. The plow controls are a built-in power hydraulic system, consisting of a high pressure vane pump, special balanced control valve, and hydraulic rams for the front plow and wing.

For city service and arterial highways, the Walter snow fighters are either equipped with a one-way speed plow in front; or the offset V-type of plow, and they are provided with a novel type of spring mounted center pressure scraper snow blade, with power hydraulic controls. This unique center blade is stated to scrape right down to the road surface.

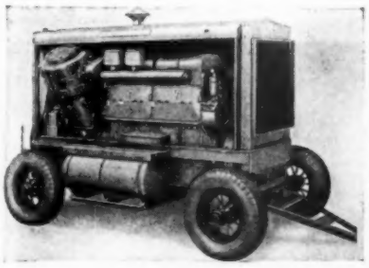
These trucks are generally equipped with standard or special types of dump bodies, or other types of bodies, for all year service, where the pulling power, speed and general ability of these trucks can be used to good advantage, as well as for their main function of snow removal.

The Walter Snow Fighters are a product of the Walter Motor Co., Ridgewood, Queens, Long Island, N. Y.

▼

New Diesel Driven Air Compressors

New Diesel engine driven compressors have been brought out by the Chicago Pneumatic Tool Co., 6 East 44th St., New York, N.Y. The line includes the Class WO-2 portable type and the Class W-CO



Chicago Pneumatic Tool Co., Class WO-2 Portable Compressor

stationary type. The WO-2 has an actual capacity of 700 cu. ft. per minute. It consists of the Chicago Pneumatic Type 48 vertical, 4-cylinder, 4-cycle, medium-speed Diesel engine on common crankcase and crankshaft with a "V" type 2-stage, double-acting, water-cooled compressor, with suitable cooling systems and air receiver, all on a structural steel deck, arranged for mounting on skids or on wheels, forming a complete, self-contained portable unit.

The double-acting design of the compressor assures high, sustained efficiency, as well as smallest number and longest life of cylinders, pistons, valves and other parts, hence low maintenance expense.

Detroit's FINEST LOCATION

If "convenience" is important to you then by all means select Hotel Tuller - right in the heart of downtown Detroit - close to stores, theatres, office buildings, and all transportation. Excellent food served at low prices in the Tuller Coffee Shop and Cafeteria...Detroit's friendliest hotel.

HOTEL TULLER

800 ROOMS

WITH BATH FROM $2 SINGLE

HARRY F. O'BRIEN, Manager

FACING GRAND CIRCUS PARK

ONE OF THE SEVENTEEN

ALBERT PICK HOTELS

5000 ROOMS IN 8 STATES

DETROIT, MICHIGAN	TULLER	CHICAGO, ILL.	GREAT NORTHERN
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COLUMBUS, OHIO	FORT HAYES	ANDERSON, INDIANA	ANDERSON
TOLEDO, OHIO	FORT MEIGS	TERRE HAUTE, INDIANA	TERRE HAUTE
CINCINNATI, OHIO	FOUNTAIN SQUARE	JACKSON, TENNESSEE	NEW SOUTHERN
CANTON, OHIO	BELDEN	ASHLAND, KENTUCKY	VENTURA
ST LOUIS MO.	MARK TWAIN	OWENSBORO, KENTUCKY	OWENSBORO
		WACO, TEXAS	RALEIGH

PICK HOTELS

PICK, in print, should always suggest ALBERT PICK HOTELS

More Yards Per Dollar

A powerful, rapid-loading bucket, hauled back and forth by wire cables, offers the cheapest way to dig and move earth or to store and reclaim bulk materials, whenever the length of haul is beyond the reach of a boom or dipper-stick.

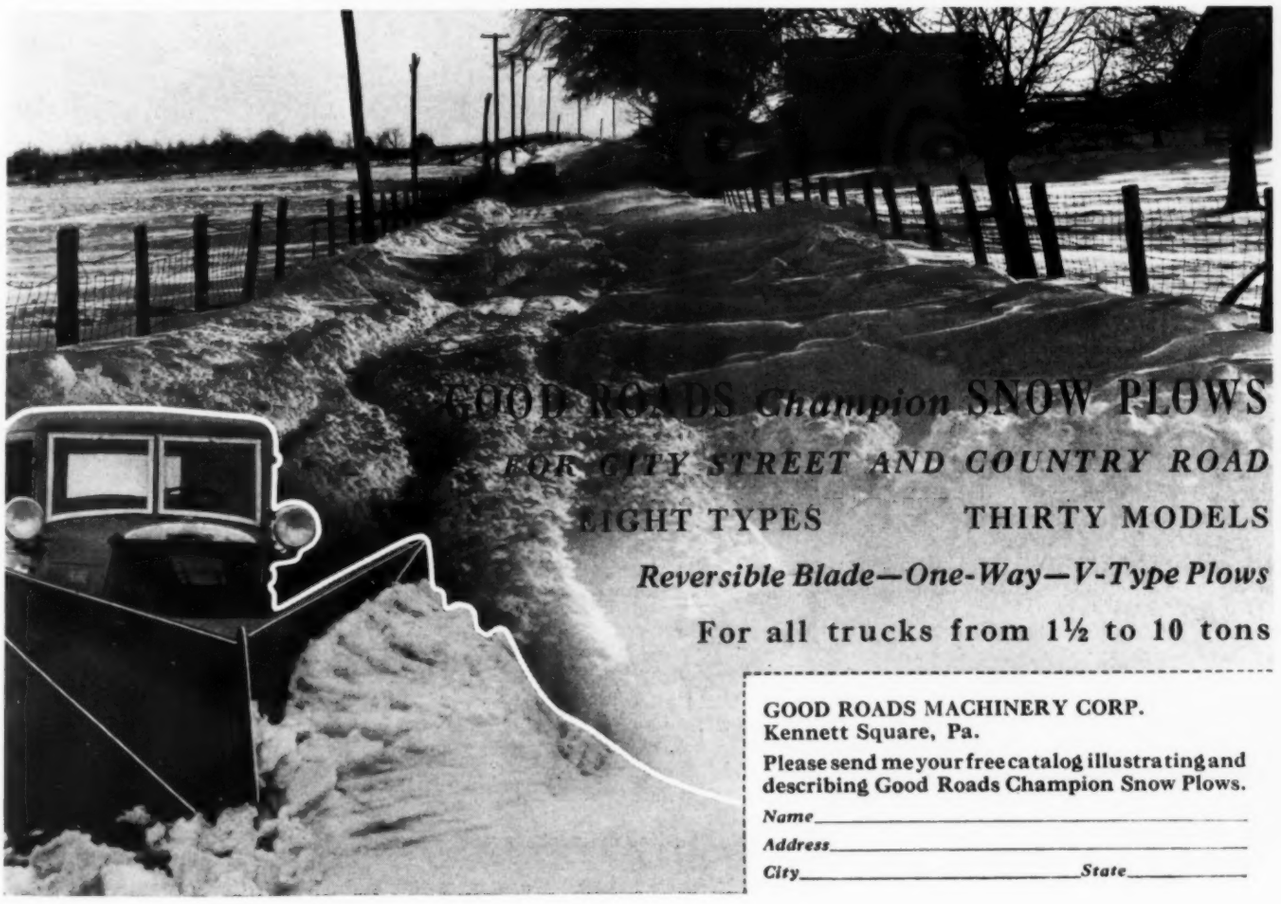
Thousands of engineers and contractors now recognize this economic principle and use Sauerman Slacklines, Drag Scrapers and Tower Excavators for their *long range* jobs.

A Sauerman machine costs less generally, than any other equipment that will dig, haul and place an equal yardage of materials. Operating and maintenance expenses likewise are very low.

Write for booklet explaining the varied uses for Cableways and Scrapers

SAUERMAN BROS., Inc.
488 S. Clinton St. CHICAGO

SAUERMAN
LONG RANGE MACHINES



GOOD ROADS *Champion* SNOW PLOWS

FOR CITY STREET AND COUNTRY ROAD

LIGHT TYPES THIRTY MODELS

Reversible Blade—One-Way—V-Type Plows

For all trucks from 1½ to 10 tons

GOOD ROADS MACHINERY CORP.
Kennett Square, Pa.

Please send me your free catalog illustrating and describing Good Roads Champion Snow Plows.

*Name*_____

*Address*_____

*City*_____ *State*_____

The air valves are of the Simplate type, which feature all CP compressors. Crankshaft counterbalances, accurately weighted, assure smooth operation. The connecting rods are of the fork end type, fitted at the crank pin end with a steel-backed, babbit-lined, wedge-adjusted bearing and at the crosshead pin end with a heavy bronze bushing. The crosshead is a steel casting with babbitted faces. The use of a common base and crankshaft for compressor and engine avoids all clutch, coupling and alignment problems.

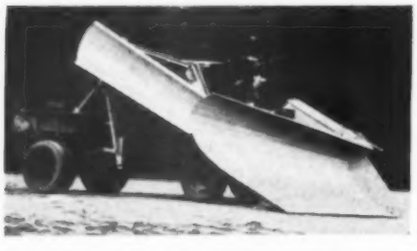
The stationary compressor uses the same engine and compressor as the Class WO-2 portable but is arranged for mounting on a permanent foundation or on skids. It is built in sizes having three or four engine cylinders, rated 112½ and 150 H.P., respectively, with two-stage compressor cylinders, having piston displacements of 655 and 830 cu. ft. per minute, respectively, for a discharge pressure of 100 lb. per sq. in. at sea level. Compressor cylinder sizes are also available for other operating conditions.

A copy of Bulletin No. 762 covering these compressors can be obtained from the manufacturer.

▼

Improved Heavy Duty Snow Plow

The Willett Manufacturing Corporation, Plymouth, Ind., has announced improvements in its hydraulic operated snow plows. This company has added refinements to its plows from time to time and has a number of its hydraulic-



Willett Hydraulic Operated Plow and Wing

operated plows in use in the snow belt today.

The accompanying illustration shows the latest improved model of the Willett hydraulic-operated plow and wing designed for use on 5-Ton to 10-Ton trucks. The manufacturers emphasize the reinforced construction of their products designed to resist strain wherever it may occur. Bulk head construction and angle reinforcement hold the plow in shape when plowing heavy drifts and rutted snows. Attention is also drawn to exceptional high lift of the wing, front and rear ends of which are separately and independently controlled. The manufacturers claim for this plow, economy and speed of operation.

▼

New Drifter Drill

Ingersoll-Rand Co., 11 Broadway, New York, N.Y., has recently introduced a new drifter drill called the DA-30. It is in the 125-lb class. A new double-opening

New Drifter Drill

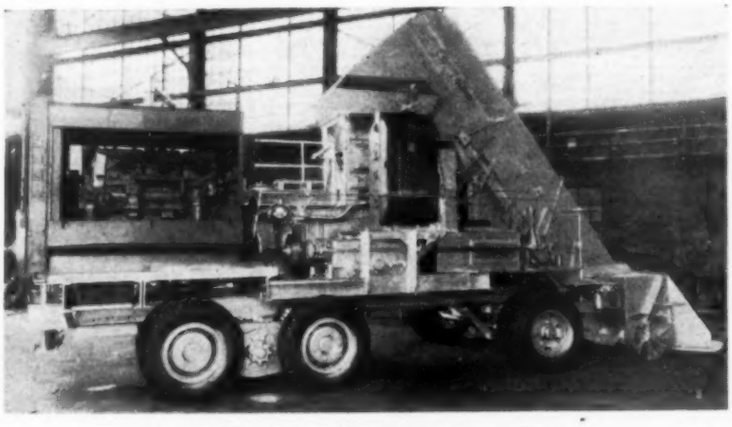
valve has greatly increased the drilling speed without increasing the air consumption. This new drill has proved to be equally as popular as its bigger brother, the DA-35 which was introduced in 1936. Further details are shown in Form 2359, copies of which can be obtained by writing the company.

▼

Road Mix Plant With Diesel Power

Recently the Iowa Manufacturing Co. of Cedar Rapids, Ia., delivered a traveling road mix plant on which a Model 6-LD-909 Buda Diesel engine furnishes the power.

This plant has 1000 gal. supply tank, equipped with kerosene pressure burners for maintaining even temperatures of the bitumen in the tank during operation. The aggregate batcher is synchronized with the asphaltic material measuring pump, and every operation is so regulated that the materials are mixed in the proper proportions.



Traveling Road Mix Plant Powered by Diesel Engine

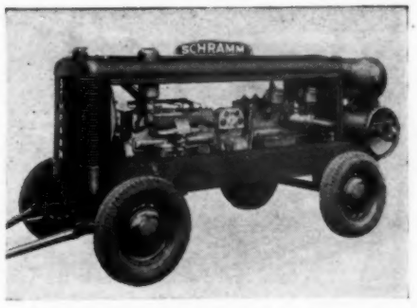
The Buda Diesel engine, Model 6-LD-909, used to power this plant is a 6-cylinder model, with 5¼ in. bore, 7 in. stroke, and 909 cu. in. displacement. This engine uses the "Controlled Turbulence" combustion system, which has been employed on all Buda Diesels for quite some time.

▼

New Compressor Line

A complete "utility" air compressor line is now offered by Schraam Inc., West Chester Penn., in sizes 85, 105, 160, 210, 260, 315 and 420 cu. ft. actual air delivery in both gasoline and diesel engine driven models.

The straight-in-line cylinder construction is used on all models together with force-feed lubrication to all seven main



Schramm "Utility" Air Compressor

bearings. Other features include electric self-starting on all models, self-aligning clutch between compressor unit and motor, mechanical intake valves, discharge valves occupying entire area of head, water cooled engine and compressor and special attention given to modern, streamlined finish and all details of construction.

For further information on this complete "Utility" line, write Schramm Inc., West Chester, Penn., and ask for Bulletin 3700-A-RS.

New Conveyor

Low first cost, lightweight, sturdy construction, and low operating costs are the principal features claimed for the new Model B-18 Atlas conveyor, which has just been announced by the Atlas Conveyor Co., Clintonville, Wis.

The machine is 20 ft. long, and is constructed for use with either a gasoline engine, or an electric motor. It may also be purchased without power, if desired.

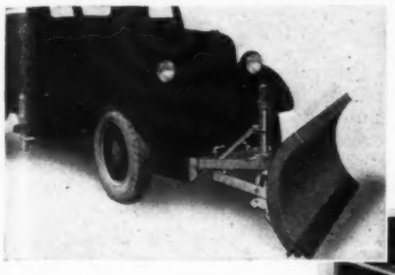
New Atlas Conveyor

Keep Roads Open • Specify

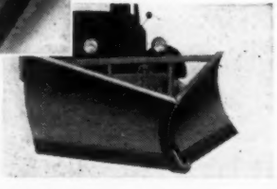
ANTHONY SNOW PLOWS

Fast • Dependable • Safe

LONG experience in building this type of equipment enables Anthony Company engineers to design fast, dependable and safe snow plows. Anthony Snow Plows are efficient, quickly attached, and always ready to go. Send for our latest snow plow bulletin No. RS, just published. It will show you the many advantages of Anthony Cutting Edge Blade Plows.



● Removes packed snow, drifts, ice, and slush.



● Above: Anthony Reversible Trip blade snow plow. Below: Anthony V type snow plow.

Send for latest Snow Plow Bulletin, No. RS.

ANTHONY CO., INC. - - Streator, Ill.

Modest or Pretentious—

WHETHER it be a single room (as above) or an elaborate suite, you will find Hollenden guest rooms modern and up-to-the-minute in decorations, equipment and furnishings. We are completing a modernizing program which make Hollenden guest rooms as fine as any to be found in Cleveland. The location is ideal, the service excellent, the food of the best and the prices moderate. Select the Hollenden on your next trip to Cleveland.

HOTEL HOLLENDEN

A DeWitt Operated Hotel **CLEVELAND** *R. F. Marsh, Mgr.*

NOW

END SLIPPERY ROADS

Quickly—Economically

Here is the most simple and efficient sand and abrasive spreader ever built. The entire unit hangs from the back endgate of your truck like an outboard motor. No special installation fittings required. Spreads sand, calcium chloride, cinders or other abrasives quickly and evenly at any speed or while truck is backing up. Write today for full specifications.

Model P

Driven by small gasoline engine. Operated by one man.

AUBURN METAL PRODUCTS COMPANY
AUBURN INDIANA

BUTLER SAND DISTRIBUTOR

PAT. NO. 2018609

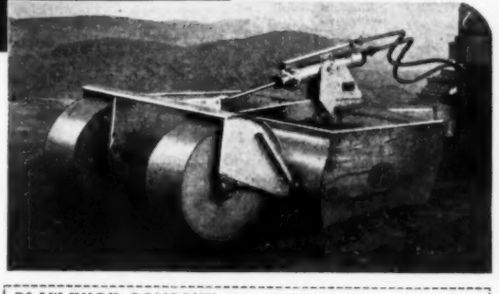
Safety for the Nation's Highways

--to make Dirt Moving Pay

BLAW-KNOX (ATECO) HYDRAULIC BOTTOMLESS SCRAPERS

The dependable performance of Blaw-Knox (Ateco) Hydraulic BOTTOMLESS SCRAPERS keeps dirt moving costs *down*—enables the contractor to operate his job on a definite schedule and at a profit.

It will pay you to investigate this BOTTOMLESS SCRAPER—also the Blaw-Knox (Ateco) Sheepsfoot TAMPING ROLLER.



Send for catalog

USE COUPON

BLAW-KNOX COMPANY
2003 Farmers Bank Bldg, Pittsburgh, Pa.

Please send:—CATALOG No. 1540—Blaw-Knox (Ateco) BOTTOMLESS SCRAPERS . . . ☐

Please send:—CATALOG No. 1550—Blaw-Knox (Ateco) Sheepsfoot TAMPING ROLLERS ☐

Individual_____

Company_____

Street_____

City_____ State_____

HEAT—when you need it.

The Littleford Model "C" Pressure Distributor has just one burner. It is the Littleford Low Pressure oil burner.

This one burner generates a greater volume of heat than any two ordinary coil type burners. But this heat is absolutely safe because the temperature of the flame from this burner is no higher than that from a coil burner.

This vast volume of safe heat is carried to every part of the tank quicker and more evenly by the Continuous Heat Flue System. No hot spots. No burned out tubes. Faster heating of bitumen with complete safety.

And the same burner used to heat the tank of the Littleford Model "C" distributor thaws out pump, valve and lines in less than 3 minutes. No extra burner needed.

Littleford Bros.
454 E. Pearl St.
Cincinnati
Ohio

Other features include: belt width, 18 in.; electrically welded angles; capacity, 30 to 70 tons per hour, depending upon material, and continuous uniform loading.

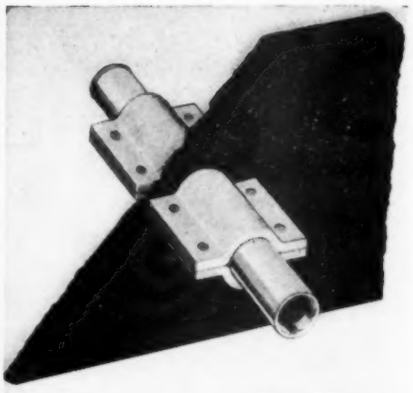
The belt is rubber-covered, 4-ply; head and foot pulleys are all steel, and machine-crowned. Head pulley, 9 in. x 20 in.; foot pulley, 6 in. x 20 in. Take-ups are at loading end, with 8 in. adjustable screws. A head pulley adjustment is provided to permit easy belt alignment.

Drive is accomplished through chain and sprockets. Road wheels have a diameter and face of 36 in. x 4 in. The truck is the rigid axle type, standard. Loading height of the machine is 12 in., and the discharging height, 8 ft., 6 in. Width overall is 5½ ft.

New Load Transfer Device for Concrete Pavements

The "T-G Bar," a device for providing a connecting support at the joint between the concrete slabs to eliminate vibration during load transfer, and at the same time permit free lateral slab movement during temperature changes, has just been bought out by the Five-Way Expansion Joint Co., 20 North Wacker Drive, Chicago, Ill.

The T-G Bar consists of a pair of stress reducers, a metal sleeve, a dowel and two caps for closing the ends of the sleeves and seal a lubricant therein. (The stress reducers and the sleeves are made of special analysis steel stampings.) An additional feature is a heavy coating of zinc. This galvanized coating has a definite affinity for concrete. The result is a permanent bonding of the concrete with the stress reducers and the sleeve. The dowel, a perfectly smooth, round, cold rolled bar, fits tightly within the sleeve which, when lubricated, forms a metal bearing, and allows it to float freely during expansion and contraction periods and in load transference. The dowel inside its metal sleeve never comes in contact with the concrete. A heavy coating of graphite grease on the dowel, together with the sealed reservoirs of grease at each end of the sleeve, is claimed to assure the free movement of the dowel as well as protection from seep water over an indefinite period.



"T-G" Bar in Correct Position in Standard Plastic Joint. It Fits All Standard Air-Core Joints in Same Manner.

The stress reducers, which are added bearings for the dowel, are die formed from heavy gauge steel. Each consists of two pieces, held together by four rivets, two on each of the bond wings. When in place these wings lie in the horizontal plane of the slab and provide an additional bearing surface in the concrete of approximately 11½ sq. in. and eliminate practically all dowel stress. These stress reducers are drive-fitted over the dowel sleeve. The sleeves are provided with die formed stops that insure correct and proper central dowel placement so that various thicknesses of joint materials may be used. The T-G Bar is completely assembled at the factory and comes to the job ready for installation.

The T-G Bar fits all standard joints whether the material is cork, felt, rubber, asphalt or metal air core joints.

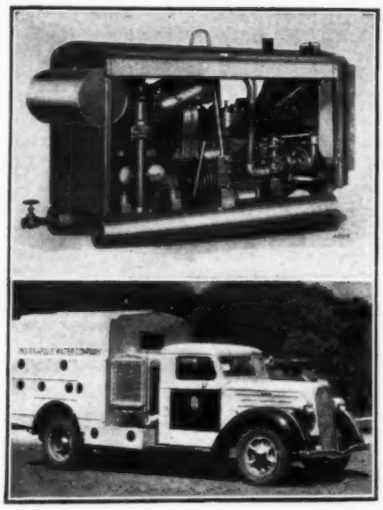
The new T-G Bar has been approved by the Bureau of Public Roads and is now included in many state standards.

▼

Utility Compressor Unit

A compact, self-contained utility compressor unit for mounting on a motor truck has been announced by the Ingersoll-Rand Co., 11 Broadway, New York.

The unit operates independently of the truck motor and transmission. It is usually placed cross-wise of the truck body so that it takes up but the minimum amount of loading space. Its dimensions are 6 ft. 7 in. by 2 ft. 3½ in., yet it is stated it will operate two I-R paving breakers, or one I-R 45 pound Juckhamer and one I-R paving breaker. The compactness of



The Compressor Unit. Lower View Shows How It Has Been Mounted by Indianapolis (Ind.) Water Co.

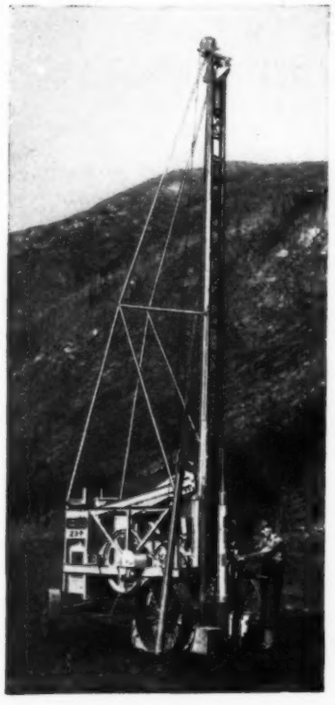
the unit allows the truck to be used for the transportation of tools, men, and the other equipment required for maintenance work.

The unit weighs but 2100 lb. and is equipped with a lifting bale so that it can easily be lifted off the truck and put in operation on the ground should this be necessary. Changing from one truck to another is also easily handled in a similar manner.

▼

New Prospecting Drill

The 23-P placer prospecting drill, a compact, modern, all-welded, all-steel, light weight easily transported unit, has been added to the Bucyrus-Armstrong line by the Bucyrus-Erie Co., South Milwaukee, Wis.



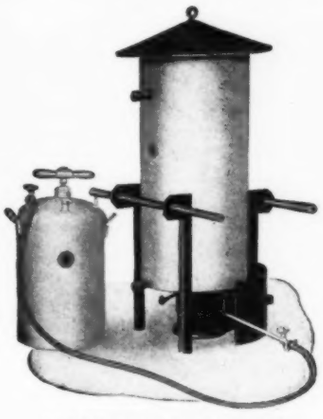
The 23-P Placer Prospecting Drill

Built especially for placer test-hole work, the 23-P is stated to provide exceptional accuracy in the obtaining of samples of gold and other minerals. Pipe driving and pipe pulling, the two most important phases of placer test-hole drilling, are provided for in the 23-P with a special spudding beam having two positions for the pitman connection. One position gives the machine a very rapid down-stroke for effective pipe driving; the other position produces a powerful up-stroke for pipe pulling. Although a comparatively light machine, the new drill swings a heavy string of tools that permits high-speed drilling. Other outstanding features include easy control of all drilling operations, geared hoist and worm feed on the bull reel, all-steel derrick with 8-point pipe bracing, rubber shock-absorber for effective use of steel line, and wheel or truck mounting. Because of these mountings, the 23-P can be quickly moved around in the field or taken from one location to another easily and with minimum loss of time. Full details may be obtained by writing to Bucyrus-Erie Company, South Milwaukee, Wis.

DON'T STOP!

WHEN COLD WEATHER COMES

USE LITTLEFORD WINTER HEATING UNITS

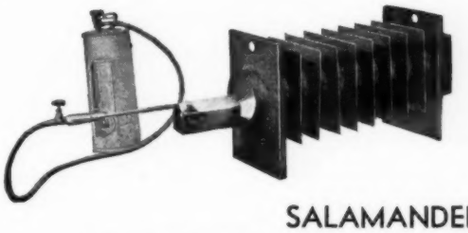


WATER HEATERS

Heat 300 gallons of water from 70 degrees F. to 175 degrees F. per hour or 400 gallons to 150 degrees F. Burns kerosene. Also wood burning types.

CONCRETE HEATERS

Littleford Heaters fit any size, make, or model of Concrete Mixer or Paver without drilling any holes or cutting or threading any pipe.



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Heating ability equivalent to six wood burning salamanders. No soot, smoke or dirt. Safe, 4 gallons of kerosene burns 10 hours.

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One piece heavy construction. Grate bars 12" off floor. Safer than old style leg type. Long lasting.

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NO PLUGS AND FEATHERS NO EXPLOSIVES

Splits rock fast. Uses your air equipment. Cuts rock handling costs. No tool upkeep. Nearly 4½ times faster than using feathers and wedges. Foolproof. Tougher than any stone. Amazing performance. First cost is last. Get this new tool for that next job.

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SHORTER CABLE OVERHAUL
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POWER-ARM COMBINATION GIVES GREATER DIGGING POWER

For EXTRA PAYLOADS

Williams Buckets master the toughest digging work in short order. Use one on your next job and see the difference in both output and profit.

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WILLIAMS
POWER-ARM, POWER-WHEEL, MULTIPLE-ROPE, DRAGLINE ..... buckets

WITH THE MANUFACTURERS

$4,000,000 Expansion Program For Allis-Chalmers

The Tractor Division of Allis-Chalmers Mfg. Company announces an expansion program costing approximately $4,000,000. This program consists of additional buildings and equipment at the West Allis Works for tractor production; buildings and equipment at the La Crosse implement plant, and additional equipment at the Springfield and La Porte plants. These new facilities will give Allis-Chalmers Mfg. Company a greater production capacity than it has had in the past.

▼

Chicago Pneumatic Opens Salt Lake Branch

Effective Sept. 1st, 1937, Chicago Pneumatic Tool Co., 6 East 44th St., New York, announces the opening of a direct factory sales and service branch at 119 West Second South, Salt Lake City, Utah. Mr. Otto A. Ray has been appointed manager.

▼

C. E. White Joins Sales Staff on Waukesha

C. E. White

Cecil E. White, formerly sales promoter for the Milwaukee Division of the Standard Oil Co., has joined the sales staff of Waukesha Motor Company's Gas Power Division. He will assist Mr. Kilpatrick in the promotion of the new automatic power units, recently announced, as well as the Waukesha automatic deluxe gas power units. Mr. White will devote his time to sales promotion as well as sales work in the field. A graduate of the University of Wisconsin in 1921, his schooling and experience combine well to give him the proper background for this new activity. His technical training consists of work as an instructor in agricultural engineering at the University and in automotive engineering at the American School of Correspondence in Chicago. During this time he also assisted in the revision of texts and a cyclopedia on automotive engineering as well as preparing a treatise on practical radio. Subsequent technical experience was gained as a service engineer for the Allis Chalmers Manufacturing Co. For the past twelve years Mr. White has been engaged in sales and sales promotion work for the Standard Oil Co., directing salesmen's activities and conducting sales training meetings. He has a wide acquaintance with sales promotion and field sales activity.

New 10 Year High In Employment For Worthington

Latest statistics available from Worthington Pump and Machinery Corporation, Harrison, N.J., show a greater number of corporation employees than at any other time during the past ten years. Increased activities at the corporation's plants at Harrison and Newark, N.J.; Buffalo, N.Y.; and Holyoke, Mass., have necessitated increasing the total number of employees 86 per cent since 1932. Compared with 1929 totals, the present figure shows an increase of 6 per cent. This new high in employment is due apparently to the large volume of orders now going through the Worthington factories. A recent statement by H. C. Beaver, president, was to the effect that unfilled orders were at the highest level in 17 years.

▼

New Dealers for Ransome

Ransome Concrete Machinery Co., Dunellen, N.J., builders of concrete and industrial mixers, have, in their expansion program, appointed Edelen & Boyer Co., 236 N. 23rd St., Philadelphia, Pa.; Wm. T. Johnston Co., 214 Vine St., Cincinnati, O., and W. T. Walsh Equipment Co., 3088 W. 106th St., Cleveland, O., to handle their line of truck mixers and agitators.

▼

Neal Higgins Heads International Industrial Sales

The continued expansion of International Harvester's industrial tractor and power unit business has necessitated a realignment in its sales department personnel. As a result, Neal Higgins has been placed in charge of all industrial tractor and power unit sales through branches, dealers, and manufacturers, while R. C. Flodin, heretofore in charge of the division, has been assigned new responsibilities.

Mr. Higgins has been closely identified with the sale of the Company's industrial power lines for the past five years. He was for three years traveling industrial sales representative on the Southern District before being called to the Chicago office early last year to promote tractor and power equipment sales through dealers in the entire country. Long familiarity with dealer problems, extensive observation of power users' requirements throughout the country, and a broad knowledge of engineering and manufacturing procedure well qualify him to direct the work of this division. He will also, as formerly, devote his attention to the promotion of sales through dealers.

To Mr. Flodin falls the task of coordinating the work of the engineering, manufacturing, and sales departments as applied to the industrial and agricultural power lines, a new post created by the necessity of meeting the ever-growing demand for modified units and the development of special equipment to fit the changing requirements of power users in many fields.

W. M. Parrish will continue to work with the numerous manufacturers of

allied equipment in the development of new applications of International power and its adaptation to changes and improvements in the design of current models.

▼

New Office for the Linde Air Products Company

The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation, 205 East 42nd St., New York, N. Y. has signed a contract for the occupancy of a new, fireproof office building at 729 North Pennsylvania St., Indianapolis, Ind. The new building, a 2-story structure, is to be ready for occupancy on or about November 1, 1937, and will provide space for the Linde District Office and a repair and service station for Oxweld oxy-acetylene welding and cutting apparatus. The new building will be of attractive brick and limestone construction. When it is completed, the Linde office, now located at The Prest-O-Lite Company, Inc., Speedway plant outside Indianapolis, will be transferred to the North Pennsylvania Street location in order to facilitate the handling of increased business activity in the Indianapolis area.

▼

R. R. Davis Promoted at Westinghouse

R. R. Davis, formerly apparatus advertising manager of the Westinghouse Electric & Manufacturing Co., has been appointed assistant to the general advertising manager of the company. His appointment is announced by S. D. Mahan, General Advertising Manager. Mr. Davis has been associated with Westinghouse advertising activities since 1910. For the present, his offices will continue to be in the East Pittsburgh Works, though he will be located in the new Pittsburgh headquarters of the company as soon as advertising offices can be established there.

▼

R. J. Smith Now With Skelly Oil Co.

Rollin J. Smith has become a member of the asphalt department of the Skelly Oil Co., Kansas City, Mo. Mr. Smith was formerly a design engineer of the Kansas State Highway Department and is well known in engineering circles in that part of the country. For several years he has been secretary and treasurer of the Kansas Engineering Society.

▼

O. B. Avery Co. Now Distributor For Broderick & Bascom

Broderick & Bascom Rope Co., St. Louis, Mo., has appointed O. B. Avery Co. as its distributor at St. Louis, Mo. The Avery Co. will carry ample stocks of B. & B. standard construction as well as flex-set preformed wire rope at St. Louis.

▼

R. C. Larkin Co. Opens New Headquarters

Rex C. Larkin, President of the R. C. Larkin Co., equipment distributors in Chicago, announces the opening of their new headquarters at 3001 S. Wabash Ave., Chicago, in a new building designed and constructed specifically to serve the construction industry.

The company has been operating in Chicago and surrounding territory for several years and is well known in that territory. This organization has also been prominent in the activities of the Associated Equipment Distributors.

The R. C. Larkin Company are distributors for such prominent accounts as Sullivan compressors, Thew-Lorain shovels and draglines, Universal-Lorain crawler and motor truck shovels and cranes, Allis-Chalmers tractors, Buffalo-Springfield rollers, Baker bulldozers and road graders, the Euclid Road Machinery Co.

The building is located at the corner of South 30th and Wabash Aves. It covers an area of 125 x 100 ft. On the Wabash Ave. side a large display room is located in which will be displayed tractors and other equipment. To the south of the display room is a Repair Parts room, fitted with bins and storage space enabling them to render prompt parts service on all their lines.

The balance of the ground floor is devoted to a repair and machine shop. This department is fully equipped in all respects, including an overhead traveling crane, and will take care of all rebuilding and service operations. The offices for the executives, salesmen and other departments are located on the second floor, which is approximately 80 ft. x 40 ft. Each member of the organization has an individual office, equipped in the latest mode with fine woodwork, new office equipment, indirect lighting, venetian blinds, etc. An apartment is provided for the custodian who resides on the premises at all times.

▼

Veterans of Cement Industry Honored

Two veterans in the cement industry, with total service records of more than 75 years, were honored last month when 35 business associates of J. A. Ahnfelt and A. G. Carlson, retiring operating manager and chief engineer respectively of the Universal Atlas Cement Co., United States Steel corporation subsidiary, tendered them a farewell luncheon at the Union League club, Chicago. Mr. Ahnfelt has been with the company for 42 years and Mr. Carlson 34 years. P. C. Van Zandt, vice-president of Universal Atlas, presided and talks were made by B. F. Affleck, former president of the company, O. N. Lindahl, comptroller and E. D. Barry, manager of industrial relations. Numerous telegrams from plants and offices of the cement company were read felicitating Messrs. Ahnfelt and Carlson on their records and extending good wishes for the future.

▼

Link Belt Elects Vice Presidents

Mr. Alfred Kauffmann, president, Link-Belt Co., announces that at the quarterly meeting of the board of directors, held in Chicago Sept. 28, Mr. William C. Carter and Mr. Edward J. Burnell were elected vice presidents. Mr. Carter, a mechanical engineering graduate of the University of Illinois, joined the Link-Belt Pershing Road plant or-

The Buckeye Clipper
1/2-5/8-3/4 YARD
METERED Vacuum CONTROL
big yardage
LITTLE EFFORT
Here's a machine that piles up big yardage without calling for marathon endurance from the operator.
METERED VACUUM CONTROL speeds up digging by making every swing of the dipper fast and accurate. Finger tip pressure by the operator commands instant response from the machine.
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CLAMSHELLS · DRAGLINES
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FINDLAY, OHIO

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Special

HIGHWAY SPREADER!

With truck, driver and one operator standing at the back, this sturdy sanding device spreads 12-20 miles of road per hour, any desired width from 10 to 30 feet. *The savings effected justify purchasing at the present low price!*

WRITE FOR CIRCULAR

The Benedict Manufacturing Co.

BIG RAPIDS, MICHIGAN

Territory Open for New Distributors

ganization in 1902 as a draftsman. He has consecutively held the positions of engineering department supervisor, construction superintendent, plant superintendent, plant general manager, and in recent years has been in charge of company production, with headquarters in Chicago. Mr. Burnell, a mechanical engineer, from Lehigh University, joined the Link-Belt Philadelphia plant organization in 1913 as a draftsman. He has consecutively held the positions of salesman at the company's Pittsburgh office, district sales manager at Boston, district sales manager at Pittsburgh, general sales manager of western division territory with headquarters at the Pershing Road Chicago plant, and more recently has been general manager of this plant.

▼

"Caterpillar" Enlarges Factory

Half-a-million dollars worth of factory additions are nearing completion at the Peoria, Ill., plant of Caterpillar Tractor Co. The new buildings, when completed, will consist of a two-story, brick and steel structure to house the engineering, tool design and apprentice departments; and a 101 ft. x 900 ft. addition to the machine shops. The latter building will contain two conveyor type tractor assembly lines. The largest single unit will cost approximately $200,000, and will consist of an addition to the present road machinery building. This structure will contain 190,000 sq. ft. of floor space, and will be used as a storage room for the company's diesel powered track-type tractors and road machinery.

▼

Mack Appoints Chief Engineer As Vice President and Director

At a meeting of the board of directors of Mack Manufacturing Corp., L. C. Josephs, Jr., Chief Engineer, was elected vice president and member of the board.

NEW LITERATURE

Snow Removal Equipment—"Winter Warfare," is the title of a 15-page illustrated booklet, just issued by Caterpillar Tractor Co. Pertaining to snow removal problems and their economical solution, the booklet contains photographs with explanatory captions, showing "Caterpillar" diesel tractor and auto patrol at work on winter maintenance jobs the length and breadth of the snow belt. The costs and advantages of these machines when used to clear city streets, highways, and farm to market roads are discussed. Printed in two-colors, the booklet may be obtained by writing Caterpillar Tractor Co., Peoria, Ill.

Pneumatic Tired Rollers—A four-page, letter size bulletin just issued by William Bros. Boiler and Manufacturing Co., Minneapolis, gives several specifications and other pertinent information on the use of pneumatic tired rollers on various classes of road work. It includes specifications for the roller.

Tractors in Snow Removal Work—Three interesting circulars dealing with the use of its tractors for snow removal have been issued by The Cleveland Tractor Co., Cleveland, O. One discusses the clearance of snow from sidewalks, another deals with all classes of snow removal, while the third describes the various features of the tractor relating to its use in snow removal. Each circular is well illustrated with scenes of numerous difficult snow removal jobs.

Excavators—Bay City Shovels Inc., Bay City, Mich., has issued new catalogs covering several models of Bay City convertible power shovels, cranes, draglines, trench hoes and trailers. These catalogs, which will be sent on request, include the following: Catalog 30-B—Model 30, Heavy duty ½-yd.; Catalog 32-A—Model 32, ⅝-yd.; Catalog 38-B—Model 38, heavy duty ⅝-yd.; Catalog 42-B—Model 42, ¾-yd.; Catalog 45-B—Model 45, standard ¾-yd.

Paint Spraying Equipment—The Binks Manufacturing Co., 3114 Carroll Ave., Chicago, Ill., has published a new complete 60-page catalog, covering their whole line of spray painting and finishing equipment. Spray guns, pressure painting outfits, spray booths, air compressors, pressure material tanks, hose and connections, respirators and masks, air and paint regulators, oil and water extractors, water wash equipment, exhaust fans, paint circulating systems, and all accessory spray painting and finishing equipment are fully described and priced. Copies will be sent upon request.

Material Handling Equipment—The Iowa Manufacturing Co., Cedar Rapids, Ia., has issued a new plant accessory bulletin No. X-1. This is an up to date bulletin covering the details and specifications on items generally termed as accessories to larger portable material producing plants. The bulletin contains information in detail on Cedar Rapids items such as: Cedar Rapids-Symons horizontal vibrating screens; revolving screens; steel trucks; bucket elevators; conveyors, lattice and channel frame type; and portable stock piling and field conveyors; feeders, both rock and gravel; steel bins; Iowa Rokarts; drag scraper buckets and accessories; special hoppers and grizzlies; drag scraper sand tanks and "V" belt drives. Accessory Bulletin No. X-1 supplements both of the previous Bulletins No. G-1 on portable rock and gravel plants and Bulletin No. WP-1 covering Cedar Rapids washing plants. The bulletin is ready for distribution to all interested parties upon request.

Explosives—A bulletin has been issued by the Explosives Department of the E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., containing a chart showing the brands of du Pont explosives and the uses to which they are adapted.

Mining and Contractors Tools—The Independent Pneumatic Tool Co., 600 West Jackson Blvd., Chicago, Ill., has brought out a 64-page catalog covering its Thor line of mining and contractors tools. It contains very complete information and specifications on all Thor rock drills, paving breakers, clay diggers and related tools.

Clam Shell Bucket—A bulletin, just issued by the Hayward Co., 50 Church St., New York, describes the new Hayward clam shell bucket, "Class E-15." This bucket has many new and interesting features, fully described in the bulletin, which also contains a chart giving full specifications and load capacities for coal, coke and other bulk materials for which this bucket is designed. Copies of Bulletin No. 670 may be obtained from The Hayward Co.

Snow Plows and Wings—The American Hoist & Derrick Co., St. Paul, Minn., has issued a catalog covering its "American" snow plows and wings. Illustrated and described are its Vee plows, displacement and speed types, its general purpose Vee plow for smaller trucks and its "American" speed plows and reversible mould board plows. Specifications for each of these types is included.

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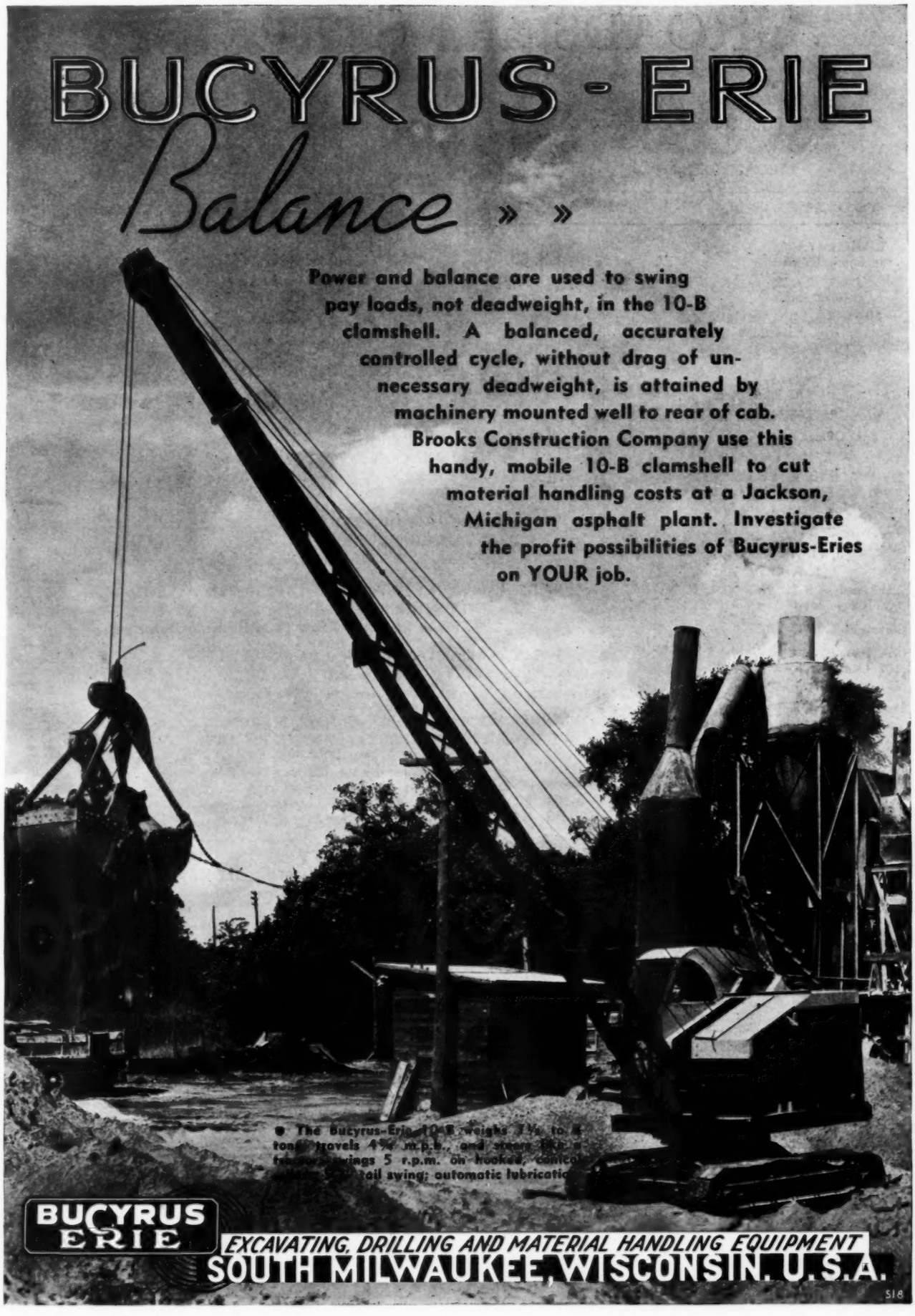
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● The Bucyrus-Erie 10-B weighs 7½ to 8 tons, travels 4¾ m.p.h., and steers like a tractor; swings 5 r.p.m. on hooked, conical
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With which have been merged GOOD ROADS and ENGINEERING & CONTRACTING

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400 West Madison Street
CHICAGO, ILLINOIS

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Copyright 1937, by Gillette Publishing Company. Acceptance under the Act of June 5, 1934, at Mount Morris, Illinois, authorized July 24, 1937. Subscription price $3.00 per year in the United States, $4.00 per year for foreign mailing.

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WRITE for our new circular showing illustration and description of Olsen Special Bench Type Compression Testing Machine. It is designed especially for testing 2" x 4" cylinders and 2" x 2" cubes. The machine is hydraulic, having two gauges, one to half and the other to full capacity. Capacity ranges of from 20,000 to 80,000 lbs.

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